



**KTC**

# **1997**

## **Annual Report**

**Kentucky Transportation Center**  
College of Engineering • University of Kentucky

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# Message from the Director

**I**n addressing the theme of our annual report, the value of research, a popular story comes to mind. Several years ago, Japan was in a severe recession. A major Japanese steel company reported losing millions of dollars due to the economic downturn. In the midst of that firm's economic woes, it opened a multi-million dollar research laboratory. At the building's dedication, the firm's president was asked why a company so financially strapped would be spending so much money for research. He answered that companies were always subject



Paul E. Toussaint

to economic uncertainties but, without research, the firm had no future regardless of the economic climate!

In America, the value of research has always come under scrutiny. Too

often, the weakness of research has not been its inherent worth, but rather how it is utilized. Over the years, Japanese corporations have gained a reputation for taking neglected American research and transforming it into lucrative products.

There is a simple lesson to be gleaned from this. For research to be worthwhile, it must be used! That requires us to emphasize several

things. First, in conducting research, we must have a close relationship with our clients to ensure that our product really addresses their needs. Second, we can no longer be satisfied with completing our research, wrapping the results in reports and mailing them to our clients without regard for how they will be used. Technologies are too integral with the way we do business. We must now work with our clients on a continuing basis to ensure that implementation of our research takes place in an efficient manner.

New technologies are being emphasized by our primary client, the Kentucky Transportation Cabinet. Intelligent transportation systems are a prime example. Those technologies are redefining our roles in providing value to our clients. We are leaving our laboratories and offices and traveling nationwide. We are abandoning our status as inventors and specialists to become generalists, system integrators, and facilitators. The complexities of those emerging technologies and their current lack of maturity requires that we must remain engaged with them for many years, through deployment and beyond, to assist our client.

This annual report is not a routine promotion touting the value of what we are doing, though we take great pride in our current research. Rather, it is a statement about how value is obtained and the steps we are taking to provide it in the future.

A handwritten signature in black ink that reads "Paul E. Toussaint".

Paul E. Toussaint, Director  
Kentucky Transportation Center

# Message from the Transportation Secretary

**A**t the end of February, 1997, Calvin G. Grayson retired as director of the Kentucky Transportation Center at the University of Kentucky. Calvin spent much of his career in public service at the Kentucky Transportation Cabinet working to improve Kentucky's roads and highways. He is widely known and respected in the transportation field both throughout Kentucky and nationally. He has served on many national transportation committees and has received numerous honors and awards for his accomplishments.

Calvin's 29-year career at the Transportation Cabinet was highlighted by his promotion to the position of Secretary of Transportation in 1977. He was the first career employee to hold that position. In 1983, Calvin became the first director of the Kentucky Transportation Center and oversaw its growth from technology exchange for local governments to include transportation research and eventually advanced training for students interested in transportation careers. He also was a leader in the Transportation Cabinet's recent intelligent transportation systems initiative. During his tenure as director, our agencies have had an excellent working relationship that has ultimately benefitted the citizens of Kentucky.

We welcome Calvin's successor, Paul E. Toussaint, as the new director of the Transportation Center. Like Calvin, Paul has had many years of public service in transportation. Prior to joining the Transportation Center, Paul was with the Federal Highway Administration (FHWA) for 29 years, the last seven being spent as Division Administrator in Kentucky. Paul established an

excellent working relationship with the Kentucky Transportation Cabinet. While Division Administrator at FHWA, he reorganized the Division Office emphasizing a customer-based orientation and the accelerated deployment of new technologies. Paul also played a critical role in our agency's ability to gain federal sponsorship of several major technical programs.



James Codell

We look forward to continuing the same excellent relationship between our two organizations under Paul's administration. We are confident that Paul is very capable of building on Calvin's numerous accomplishments and will lead the Kentucky Transportation Center into the next century.

We also extend a note of gratitude to Dr. Donn Hancher, Chairman of the Civil Engineering Department, for heading the search for Calvin's successor and serving as interim director of the Kentucky Transportation Center during that period.

A handwritten signature in black ink, appearing to read "James C. Codell III".

James C. Codell III, Secretary  
Kentucky Transportation Cabinet

# Value of Kentucky's Transportation Research

*The theme of this Annual Report is the "Value of Research." The investment in research in Kentucky has been and continues to be a wise investment in increased safety, productivity, and a much better transportation system for our citizens. Research in transportation does not cost, it pays!*

*Listed below are some examples of how the Center's transportation research has enhanced Kentucky's Highway System and saved taxpayers millions of dollars.*

## **Intelligent Transportation Systems (ITS)**

The Center's work in the area of Intelligent Transportation Systems is providing immediate benefits to commercial vehicle operators, enforcement agencies, and the general public. Through projects such as the Advantage I-75 Operational Test Project, the CVISN (Commercial Vehicle Information Systems and Networks) Model Deployment, and the ITS/CVO (Commercial Vehicle Operations) Mainstreaming initiative, the Center has been able to assist the Kentucky Transportation Cabinet in moving to the national forefront in ITS applications for CVO and assisting the states of the Great Lakes and the Southeast. These initiatives are demonstrating real-world benefits, including improved efficiency and reduced delay for truckers, reduced paperwork for both truckers and state agencies, better allocation of enforcement resources, and more effective enforcement of safety, weight, and credentials requirements. The Center also has assisted Kentucky and its urban areas with the planning and development for Advanced Traveler Information Systems and Advanced Traffic Management Systems.

## **Safety Belt Research**

Safety belt research and usage surveys have been conducted by the Transportation Center for several years. The data are used to (1) identify areas around the state for increased education and enforcement and (2) also have been used to assist in the development of safety belt legislation.

The Center also has been involved cooperatively with the Transportation Cabinet and the Kentucky State Police to improve driver safety through promotional campaigns and safety improvement programs.

Driver usage rates have increased from 4 percent in 1982, when the first survey was conducted, to 55 percent in 1996. Based on Kentucky data, if the safety belt usage rate could be increased to 70 percent, estimated annual fatalities could be reduced by 159 and serious injuries could be reduced by 1,053. The annual injury cost savings resulting from an increase in safety belt usage rate to 70 percent is estimated to be approximately \$280 million.

## **Maintenance Painting of Steel Bridges by Overcoating**

In 1991, the Transportation Center began assisting the Transportation Cabinet in developing new maintenance painting procedures for steel bridges. Many of those bridges had existing lead-based paints. The use of abrasive blasting to remove the existing paint had proven to be expensive and potentially dangerous to the environment due to the presence of lead in the paint being removed. Overcoating, the practice of applying new paint over old, existing painting was selected due to its low cost and minimal environmental impact. Between 1992 and the present, nearly 100 steel structures have been painted for a cost of approximately \$10 million. Those projects would have cost almost \$60 million if abrasive blasting had been used. The several studies that addressed bridge painting cost \$250,000. The research savings to cost ratio is about 200 to 1.

## **Distress at Intersections**

In 1991, the Transportation Center investigated numerous intersections with maintenance histories of annual or semi-annual (twice a year) milling and resurfacing. After evaluating several bituminous concrete alternatives, including chemical additives, fibers, and grid reinforcement, Center researchers recommended portland cement concrete (PCC) pavement at high traffic volume intersections. Prior to 1991, PCC pavements in bituminous-concrete-paved routes were virtually unknown in Kentucky. Since 1991, several bituminous concrete intersections have been replaced with PCC. Some PCC intersections are inlays and others are full-depth replacement. All PCC intersections are performing well. Milling and resurfacing of a single intersection costs tens of thousands of dollars and is a considerable inconvenience to the public.

## **Evaluation of Controlled Low-Strength Material (CLSM) or Flowable Fill for Trench Backfill**

In 1991, the Transportation Center conducted a laboratory evaluation of Controlled Low-Strength Material

(CLSM) mix design and two field evaluations of the Kentucky Transportation Cabinet's use of CLSM as trench backfill. The study concluded that CLSM is an excellent trench backfill material that protects the conduit, prevents settlement, provides quick turnaround, and reduces construction safety hazards to workers and the public.

Maintenance records indicate that the cost for repairing a trench settlement across two driving lanes is approximately \$2,000. Statewide, there are hundreds of settled trenches in need of repair each year. The use of CLSM as trench backfill can potentially save hundreds of thousands of dollars. The Transportation Cabinet currently offers CLSM as an alternative backfill but is considering specifying CLSM backfill in trenches under pavement.

### ***Evaluation of Transportation Facilities for Earthquake Hazard Mitigation***

Approximately 1,000 miles of emergency routes were chosen and all earthquake hazards, including bridges, along these routes were cataloged. The 276 bridges cataloged on these routes were individually analyzed for earthquake safety. Based upon this research, many of these bridges have been retrofitted for earthquake resistance. The cost of this study was \$461,000, while the cost of replacing one bridge that may collapse during an earthquake could be several million dollars. The benefit of saving several bridges could be several hundred times the cost of the study.

### ***Evaluation of Longitudinal Edge Drains and their Effect on Pavement Performance***

Poor drainage is detrimental to the service life of a pavement. As a result of this knowledge, numerous research projects have been conducted to determine the effectiveness of pavement edge drains.

Results of this pavement edge drain research conservatively assumed that the edge drains can increase the life of a pavement by 20 percent. Based on the cost of approximately \$40,000 per mile for resurfacing, a savings of \$8,000 per mile could be realized. The cost of this study was \$286,000 and would be recovered after just 35 miles of resurfaced pavements.

### ***Probability Based Design of Bridges Susceptible to Vessel Impact***

Kentucky has the second longest navigable inland waterway system in the United States; consequently, bridges crossing these waterways are susceptible to barge and other

vessel impact. This study provided guidelines for estimating impact loads on these waterways. The funding for this study was in the amount of \$50,000. To illustrate the benefits of this study, the generation of data required to develop the risk assessment model for a proposed bridge over Kentucky's navigable waterways would require an average of 600 engineering hours. These hours would be in addition to the time required to procure the data (some of the necessary information must be obtained under the Freedom of Information Act and can take up to six months to be delivered). This study allows the design engineer to generate the required data in less than one day; therefore, the cost of this study will be recovered on just one project.

### ***Seismic Analysis for the Brent-Spence I-75 Bridge over the Ohio River***

The primary objective of this study was to assess the structural integrity of the Brent-Spence Bridge when subjected to an earthquake. This bridge is on a vital I-75 artery that connects Kentucky and Ohio, and would need to be kept open to traffic during an emergency. The study showed that the main bridge will survive a projected maximum earthquake without significant damage and no loss of span. However, the approach spans are vulnerable to loss of span failure. Recommendations for retrofit have been made, and are being implemented. This study was funded for \$84,000. If this study had not been conducted and a major earthquake were to occur along the New Madrid fault, collapse of the approach spans of the Brent-Spence Bridge is highly probable. Repair costs from such an event would exceed \$10 million. Furthermore, the closure of this section of I-75, which is a major economic thoroughfare linking Florida to Canada, would result in economic losses in the millions of dollars per day.

### ***Signs for Locals Program***

During the past 10 years, the Transportation Center has administered a program of grants to cities and counties for the purchase of traffic signs for installation on non-state-maintained roads. There have been 52 cities and 36 counties participating in the program and the cost has been approximately \$1 million. However, when considering that the total annual accident costs in Kentucky are in excess of \$3 billion, the benefits have been significant in terms of improved safety and the resulting reductions in accidents and injuries.

## *About the Center*

The Kentucky Transportation Center is a unit within the University of Kentucky College of Engineering with a threefold program of research, technology exchange, and experiential education.

### **HISTORY**

With the onset of federally funded highway work in Kentucky in the early 1900s, the needs for specifying the quality of road-building materials and for enforcing specification requirements through testing became increasingly apparent. As a result, the Road Materials Testing Laboratory was established in 1914 at the University of Kentucky by Professor D. V. Terrell.

In 1928, testing services were transferred to the Kentucky Department of Highways in Frankfort. Some research, however, continued at the University. The Kentucky Department of Highways moved the Division of Research to UK's campus in 1941, and it operated the research program until 1980.

In 1980, the Kentucky Department of Transportation transferred its research program to the University of Kentucky. The Department entered into a contractual arrangement with UK to carry out its basic research program. During that period, the Department of Transportation changed its name to the Kentucky Transportation Cabinet (KYTC).

On July 1, 1984, the Center was designated a Technology Transfer Center by the Federal Highway Administration (FHWA). Currently there are 57 of these centers nationwide that serve as transportation extension services to local governments. Funding is made available through FHWA's Local Technical Assistance Program (LTAP), previously called the Rural Technical Assistance Program (RTAP).

The Center's Technology Transfer Program changed its name from "Transfer" to "Exchange" to better reflect its mutual partnerships with local, state, and federal governmental agencies, and its many industry and academic contacts.

The Kentucky Transportation Research Program and the Center's Technology Transfer Program operated as separate entities under the College of Engineering until 1988, when they merged to become the current Kentucky Transportation Center.

The Advanced Transportation Institute was established at the Center in 1989 to offer a post baccalaureate certificate in transportation system management. The Center is a major participant in the consortium of University Transportation Centers in the southeast region, including the Southeastern Transportation Center's Advanced Transportation Institute program. The Institute at UK was the first of two programs established in the southeast. Over 50 graduate students have participated in this experiential education program since 1989.

### **OVERVIEW**

#### ***Research***

The Center's comprehensive program of transportation research includes Environmental Analysis, Geotechnology, Pavements, Structures, Traffic and Safety, Intelligent Transportation Systems, Intermodal Studies, and Special Projects.

The benefits of research conducted through the years by the Cabinet and the Center have been significant. Research was, and continues to be, vital to the perpetual upkeep and growth of the transportation network. Information gained from the Center's research has affected transportation standards and methodologies, as well as provided answers to difficult problems. Center personnel are involved in numerous research projects each year, with sub-tasks bringing the total to more than 100 separate studies.

Through a cooperative agreement with the Kentucky Transportation Cabinet, the Center administers the Cabinet's research program. Other governmental agencies and the private sector also have routinely used the services of the Center. Additionally, the Center serves as the focal point to assist and facilitate in the development of an increased interdisciplinary awareness and involvement in transportation research and related services.

Currently, a major emphasis of the Center is in the area of Intelligent Transportation Systems (ITS). As part of the ITS program, the Center serves

### **Former Directors**

***Calvin G. Grayson***  
**1988-1997**

***Robert C. Deen***  
**1981 - 1988**

***James H. Havens***  
**1963-1980**

***William B. Drake***  
**1957-1963**

***D. V. Terrell***  
**1941-1957**

as the Operations Center for the Advantage CVO (formerly called Advantage I-75) Project, which is a multi-state effort to apply advanced technologies to improve traffic flow and safety along the I-75 corridor, primarily in the area of motor carrier operations.

### ***Technology Exchange***

The Center serves as Kentucky's Local Technical Assistance Program providing services and technology linkage to local governments. The Technology Exchange Program also provides services to state government employees, private industry employees, as well as others involved in transportation in Kentucky.

Services include training programs, on-site assistance, a lending library, nontechnical publications, and newsletters. In the larger capacity, the Center believes technology

transfer is an opportunity to help find solutions to transportation problems and bring innovation and change by interaction with governments, universities, and business and industry.

### ***Experiential Education***

To provide students with real-world preparation, the Advanced Transportation Institute offers a unique combination of academic study and hands-on application. The highly successful interdisciplinary approach draws students from areas such as civil engineering, geography, and business administration. Students completing the program are employed by a wide range of transportation related agencies and businesses.

## ***From a bird's-eye view . . .***



*John Fleckenstein, principal research investigator, climbs to the top beams (above) to inspect this bridge and then goes over the edge (right) to get a better look at the underside of the structure.*



***Center researchers use safety precautions in their fearsome feats to get a better view of Kentucky's infrastructure.***



# *The Road to Quality*

The Center is committed to improving the quality of its services as well as improving internal efficiency and effectiveness. We have made steady progress since beginning this journey.

On our road to quality, our efforts have included regular meetings with staff to identify needed changes at the Center and evaluate how we can accomplish our goals and better serve our partners and customers. We have formed several teams to study how to best achieve needed changes. These teams represent efforts to identify and implement internal improvements to enhance efficiency and effectiveness at the Center. This year, these teams include the following:

**Continuous Improvement Team**—To oversee our progress.

**Paperwads Team**—To identify ways to eliminate unnecessary paperwork and to streamline administrative processes.

**E.A.T. (Education and Training) Team**—To ensure that the training needs of the staff are met. This team established procedures for the notification of staff about training opportunities and wrote a procedures manual of the Center's general operations.

**Marketing Team** (formerly the Annual Report Team)—To establish guidelines and direction for marketing the Center. The team will discuss the annual report, web site, a brochure, a video, publications, and reports.

The Center will continue to address the often difficult challenges of continuous quality improvement in order to provide our customers with better, more cost-effective services.

## *... to way down under*



*Above: Rich Reitenour, engineering technologist, gets his feet wet to inspect a culvert.*

*Below: John Fleckenstein (kneeling) and Mike Shull, graduate student, conduct hands-on investigation inside this culvert.*



# **Review of Activities FY 96-97**

The following pages present the Center's technology exchange, research, and experiential education activities during the July 1, 1996, to June 30, 1997, fiscal year.

# TECHNOLOGY EXCHANGE—

*the interaction between research and technology sponsors, and users that results in actual innovation.*

*In order for the value of transportation research or new and innovative technologies and methods to be fully utilized, there must be a process of getting that information to the end users. That process is called technology transfer, or technology exchange. By filling the void between researchers and those charged with maintaining the nation's transportation system, it prevents valuable information from getting shelved and forgotten.*

Since 1984, the Center's Technology Exchange Program has been delegated the task of obtaining the latest information, methods, and innovations from across the United States and beyond to transfer to Kentucky's transportation community.

Center staff use various tools to accomplish its task, including the following:

- ◆ A training program for all levels of transportation employees.

- ◆ Publications, including newsletters, handbooks, and directories.
- ◆ An information service featuring a state-of-the-art library.
- ◆ On-site technical assistance and demonstrations.

To deliver these services, the Center maintains an extensive mail list of transportation providers and users. A toll-free phone number is available for client use.

The following pages highlight the major technology exchange activities conducted during this fiscal year.

# Technology Exchange

The most critical element in exchanging information that can improve Kentucky's transportation system is the human factor—personal contact. That's why the Center's Technology Exchange Program regularly keeps in touch with the transportation community through partnerships with governmental and industry associations and by participating in various meetings and activities of interest to transportation employees at all levels. Through these contacts, Center staff can continually assess the needs of its clients and gauge the part it can play in best filling those needs.

One way the Center provides assistance to its clients is by serving as Kentucky's Local Technical Assistance Program (LTAP), partially funded by the Federal Highway Administration. This program is a network of 57 Technology Transfer Centers nationwide that share information and ideas to help provide better services at lower costs.

## Training

Training is one of the Center's most critical means of exchanging transportation knowledge. Each year since the training program began, the Center has added more low-cost training opportunities and new sites around the state to enable more individuals to attend without having to spend

so much time away from their work site or incur expenses that may deplete already tight budgets. This fiscal year, the Center conducted 107 workshops, conferences, teleconferences, or seminars attended by 3,628 participants (see chart below). Training time ranged from three hours to a full week. Almost half of the workshops offered were scheduled in response to direct requests from local and state government agencies, in addition to private industry.

## Focus on worker safety

This year, safety was a major focus of the training program. Over 900 local and state government, contractors, and utility company employees received Work Zone Traffic Control and/or Flagger training.

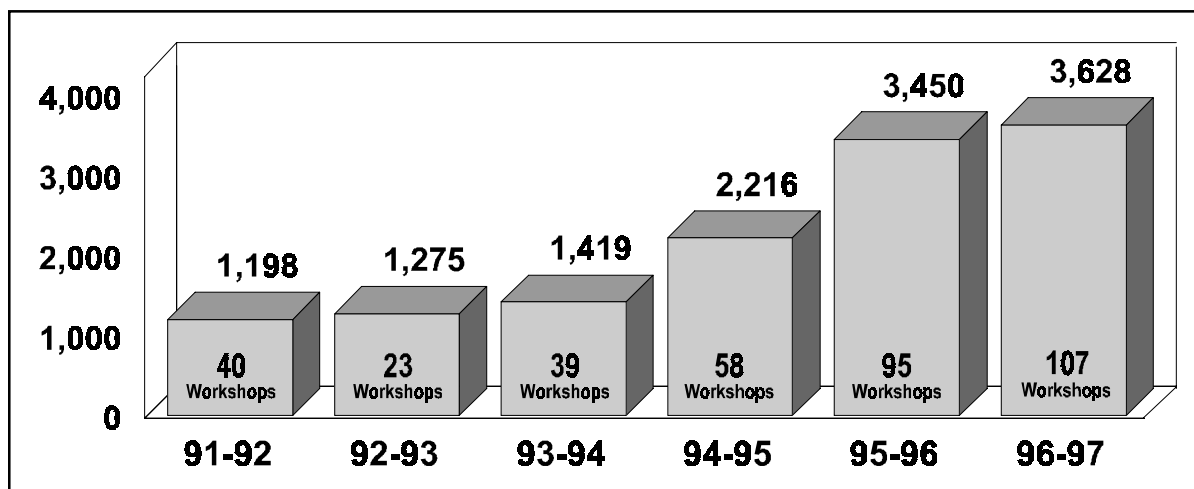
## Why more work zone traffic control training?

There are some "mores" that generate an increasing need for proper work zone traffic control. These "mores" include:

- ♦ *More autos*
- ♦ *More drivers*
- ♦ *More trips*
- ♦ *More speed*
- ♦ *More impatient drivers*
- ♦ *More trucks*
- ♦ *More cellular phones and improved radio systems*
- ♦ *More vehicles with very quiet and comfortable interiors*
- ♦ *More legal concerns*
- ♦ *More streets and roads needing repair*

All of the "mores" listed above point to the need for continued awareness and training in proper work zone traf-

**Participants and Number of Workshops**



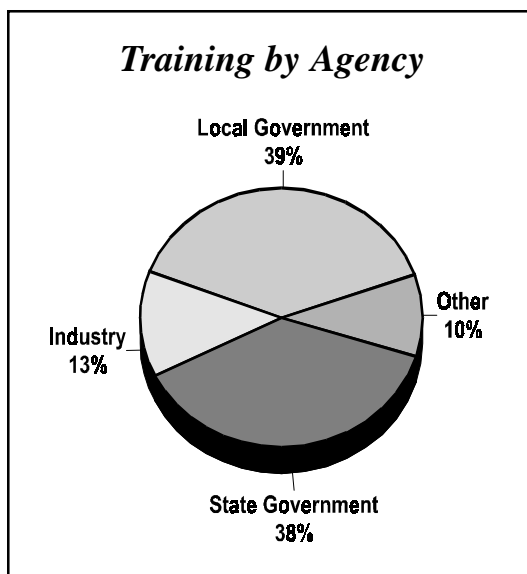
fic control. The number of safety courses being offered by the Center continues to grow at an accelerating rate as agencies continue to request the training. The audience is expanding to include state district personnel, specialty contractors for the state, construction contractors, and a variety of utility organizations.

Some areas of highway safety (driver behavior, vehicle design, highway design and operations) are being improved in that the total fatalities have been significantly reduced during the last 20 years. However, deaths and injuries in work zones continue to grow at an alarming rate. The need for training and use of improved tools to communicate with drivers and safeguard the highway workers continues to be a challenge.

During the past 27 months, the Center's regional engineer has conducted 75 work zone traffic control courses for over 2,400 participants around the state.

### ***New snow and ice control technology***

Another area of concentration by the Center is the newest technology for snow and ice control. Anti-icing, Road Weather Information Systems (RWIS), and the latest in snow and ice control equipment were the subjects of a special workshop held in Lexington during the beginning of winter, 1996-1997. "Anti-Icing" is the technique of applying chemicals to prevent ice from forming or bonding, instead of waiting to melt it after bonding has occurred (called



deicing). Road Weather Information Systems are the new equipment and systems that dictate the "when and where" to apply the chemicals just as the freezing begins to occur. The workshop included a display of new snow and ice removal equipment such as plows, scoops, and liquid chemical distributors.

Since Kentucky usually doesn't experience hard winters as do the northern states, it was questionable as to whether there would be much interest in such a workshop. However, interest kept growing as all branches of city, county, and state governments, plus some vendors, responded. Ultimately, the meeting had

to be moved to the Lexington Fire Fighters Training Center where room could be provided for the 120 attendees and to have a place to demonstrate the snow and ice fighting equipment.

Another similar workshop is being planned for the coming year.

### ***Road Supervisor's Training Program has resulted in 100 Roads Scholars!***

The Road Supervisors' Training Program continues to be one of the Center's most popular means of sharing new technology and innovation. This special training program provides basic knowledge on topics such as personnel management, equipment management, and road surface management. The completion of this program leads to the Roads Scholar designation. At the end of the 1996-97 training year, 18 new people had completed the program and will be recognized at the 33<sup>rd</sup> Annual Transportation Forum in



*Although local and state highway agencies are the usual participants at our training workshops, the Center teamed with the Kentucky River Foothills Development Council in Richmond, Kentucky, to present this work zone traffic control training.*

*Regional transportation engineer, John Hibbs (standing), provided training for candidates participating in the Council's "Women in Highway Construction" program. So far, these candidates in the program have been very successful in finding jobs in highway construction.*

*Below: The Snow and Ice Conference, held at the Lexington Fire Fighters Training Center on Nov. 13, 1996, provided an opportunity for participants from across the state to learn new technologies and methods for fighting snow and ice on Kentucky's roads.*



*Above: The workshop included a display of new snow and ice removal equipment such as plows, scoops, and liquid chemical distributors.*

September, 1997. The new participants bring the total to 100 Roads Scholars, representing 55 cities, 41 counties, and four state highway district offices.

### ***Partnerships help Center succeed***

#### ***APWA partnership***

The Technology Exchange Unit attributes much of its success to cooperative and effective partners. One example, the Kentucky Chapter of the American Public Works Association, continues to partner with the Center both with its certification program and APWA's annual fair and equipment show.

#### ***Asphalt partnership***

The three-way partnership of the Transportation Cabinet, the asphalt industry, and the Center continued this fiscal year with the Bituminous Hot-Mix Asphalt Training and Certification Program. The goal of the Program is to provide better quality asphalt pavements for Kentucky by reviewing and testing approved Kentucky methods for asphalt pavements.

In this, the second asphalt training season for the program, Technology Exchange staff worked with instructors from the Transportation Cabinet's Materials Division and from several asphalt companies to administer eight Plant Technologist courses and three Mix Design courses. The Plant Technologist course is 3.5 days of materials review,

with skill and written testing. To qualify for the Mix Design course of 4.5 days, an individual must be a certified Plant Technologist. This year, 177 individuals were trained and certified as Plant Technologists, and 55 individuals were certified as Mix Design Technologists.

Since certifications in bituminous hot-mix asphalt technology are valid for only three years, all professionals working on asphalt pavement in Kentucky will need continued training and testing in the future. It is planned that training requirements for Superpave technologies be incorporated into this program in the future.

### **Other tools the Center uses to transfer technology**

#### ***Publications***

The Center provides information through publications by producing its own printed materials as well as supporting a well-stocked transportation library. This year, Technology Exchange staff produced the following publications:

- ◆ Four issues of the LTAP newsletter, *The Link*
- ◆ Kentucky Transportation Directory, 10<sup>th</sup> Edition
- ◆ *Flagging Tips* brochure
- ◆ A manual on metrication for use in the new metric workshops.
- ◆ Metric version of the *Inspectors Job Guide*
- ◆ Proceedings from the 32<sup>nd</sup> Transportation Forum
- ◆ Annual Report for the Center

- ◆ Updated Training Catalog
- ◆ Updated Video Catalog

Center staff continue to edit the Kentucky Chapter American Public Works Association quarterly newsletter. This fiscal year, they also assisted with the Center's CVISN (Commercial Vehicle Information Systems and Networks) *Mainstreaming* newsletter, and a research final report, *Southern Kentucky Corridor (I-66) Study*.

### ***Library and Information Service***

The Center's Library is the only transportation library in Kentucky, and serves as a transportation resource for the following groups and individuals:

- ◆ Kentucky's local and state government employees
- ◆ UK faculty, students, and staff
- ◆ Center staff

- ◆ Industry employees
- ◆ Others needing transportation information

Library personnel, of course, welcome anyone with a need for transportation information. Drop-in visitors also are welcome. Agencies and individuals who cannot visit in person, may contact the Library via phone, fax, or e-mail.

Besides the traditional resources of monographs, technical reports, and journals, the Library has a growing CD-ROM collection and an extensive video collection, all of which may be borrowed.

This year, the Library had 4,468 visitors, circulated 1,264 items, answered 782 reference questions, and added 833 volumes to the collection. The Center employed a library assistant to help the librarian with public service and other library operations. The Library also added a public access CD-ROM station.

### ***Topics covered in this year's training sessions***

- |                                              |                                                                |
|----------------------------------------------|----------------------------------------------------------------|
| ● Work Zone Traffic Control/Flagger Training | ● Levels I and II Traffic Signal Technician Certification      |
| ● Roadway Signs and Markings                 | ● Communications                                               |
| ● Seismic Bridge Design                      | ● Defensive Driving                                            |
| ● Roadway Incident Emergency Management      | ● Understanding Metrics (Technical and Non-Technical sessions) |
| ● Traffic Management of Land Development     | ● Construction Claims Handling/Avoidance                       |
| ● Advanced Traffic Management Systems        | ● CPM Scheduling                                               |
| ● Risk Management/Tort Liability             | ● Culvert Pipe Demonstrations                                  |
| ● NHI Hot-Mix Asphalt Construction           | ● Telecommunications Act                                       |
| ● People Management                          | ● Materials Control and Acceptance                             |
| ● Managing Roads and Streets                 | ● Optimization of Traffic Signals                              |
| ● Snow and Ice Conference                    |                                                                |

## RESEARCH—

*the disciplined pursuit of discovery and understanding  
that can lead to new ideas and new methods.*

*Research is careful, patient, systematic, and diligent inquiry or examination in some field of knowledge undertaken to establish facts or principles. Research is obtaining answers to pressing problems for which there are no immediate solutions.*

The benefits of the Center's transportation research throughout the years have been significant. Valuable data and records have been collected and developed for a multitude of studies that have been conducted in the general area of transportation.

The vast majority of studies conducted to date have produced solutions to pressing problems, led to more effective utilization of materials and mixtures, and enhanced overall operations within the Kentucky Transportation Cabinet (KYTC), the Center's main research sponsor. Listed on pages 1-2 are some implementations resulting from the Center's research that have enhanced Kentucky's transportation system.

Research conducted for KYTC and other entities has covered a broad spectrum of topics and has ranged from very short-term, problem-solving studies to long-term, developmental studies.

Listed in this section are the Center's research divisions and many of the research projects which hold the promise of providing significant savings as well as improved construction or safety standards for the Commonwealth. Of course, the final benefit of these studies can be determined only after implementation.

Shown on the next page is an example of the Center's research and evaluation of one of the new, advanced technologies promising to make our highways safer and more efficient to maintain.





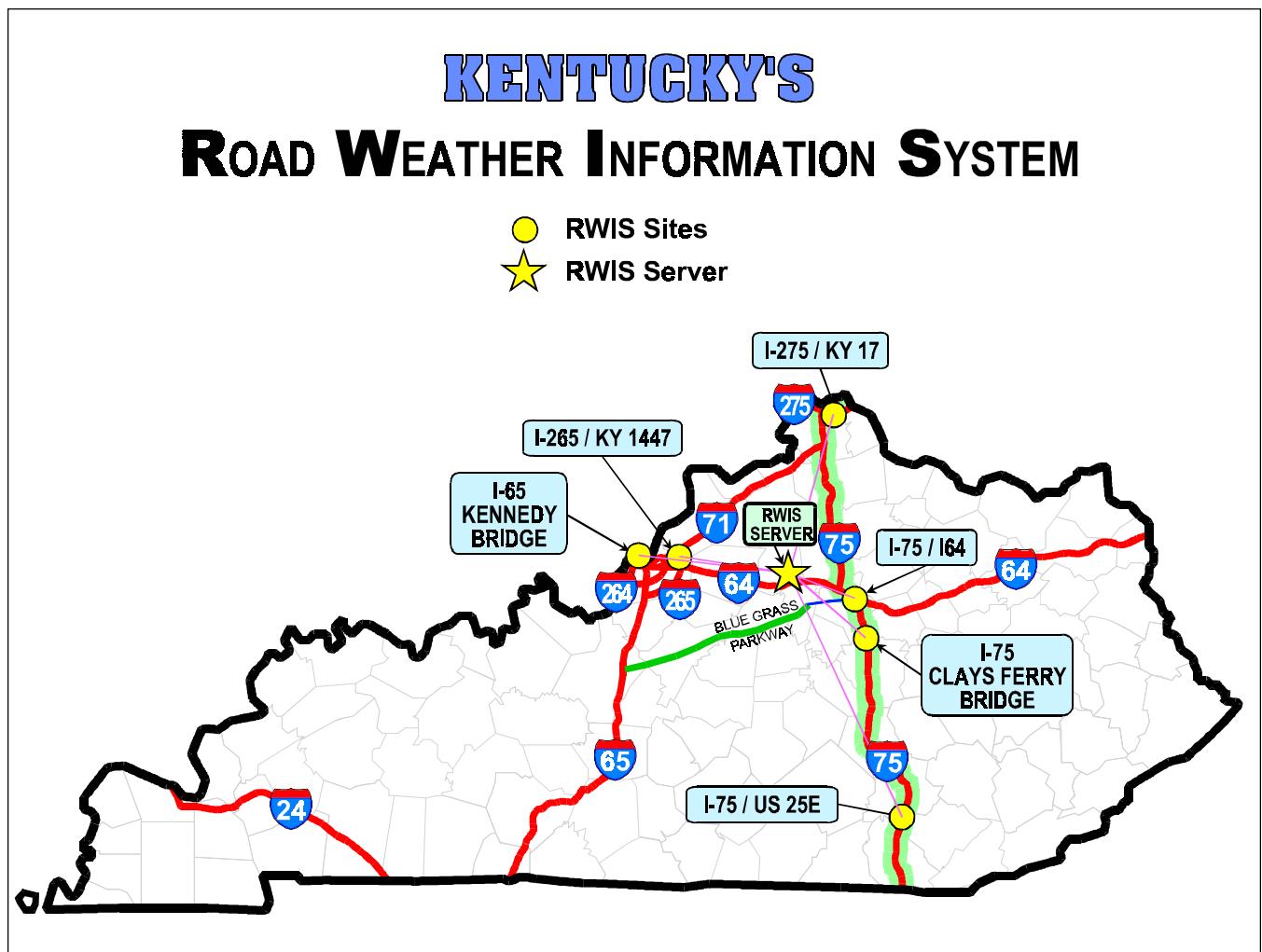
*RWIS installed on I-275 at KY 17 in Kenton County.*



*RWIS installed on I-265 at Westport Road in Jefferson County.*

The Center's *Traffic and Safety Section* and *Pavements Section* are working together to evaluate the effectiveness of an advanced technology called Road Weather Information Systems (RWIS) across the state for the Kentucky Transportation Cabinet. These systems will provide real-time information on roadway conditions during winter weather.

The field installations in the photographs above show remote processing units and sensors for measuring temperature and humidity, precipitation, wind speed, and direction.



# *Environmental Analysis*

The Environmental Analysis Section provides research and service capabilities to address current and future environmental issues impacting the transportation industry. Increasingly, safety and environmental regulations and concerns are having a significant impact on transportation agency operations.

This Section provides multidisciplinary research capabilities, state-of-the-art equipment, and technical expertise to review environmental problems and formulate solutions that are regulatory-compliant and implementable. Additionally, the Section has participated in research on a wide range of technical areas relating primarily to highway materials used in structures, subgrades, and pavements.

## **Research studies in progress**

***Painting of Steel Bridges***—Over the past six years, Environmental Analysis Section personnel have assisted Kentucky Transportation Cabinet (KYTC) officials in achieving cost-effective, environmentally-compatible painting methods for existing and new steel bridges. A major area of concern has been the maintenance painting of steel bridges containing lead-based coatings. Initial research indicated that complete removal of those coatings would be prohibitively expensive due to the requirement for containment and disposal of abrasive blasting wastes that are classified as hazardous materials.

Following that determination, Cabinet officials embarked on a unique research program wherein all KYTC bridge maintenance painting was performed by overcoating the existing lead-based paint. Since 1992, nearly all KYTC maintenance painting projects have been classified as experimental. This Section's staff have monitored those projects before, during, and after completion. Their findings were used to develop cost-effective overcoating specifications and to identify coating systems that functioned well when used for overcoating.

To date, 100 bridges have been, or are in the process of being, overcoated. The application specifications and coat-



*Section Head Ted Hopwood tests experimental protective coating for steel bridges (above) and anti-graffiti paint (left).*

ings developed in past research have provided incrementally better painting projects than the preceding ones and the unit painting costs have decreased markedly since the initial projects that were let in 1992.

Research conducted in 1996-97 focused on multi-bridge painting contracts performed on I-64 bridges in Fayette, Clark, Montgomery, Bath, Carter, Rowan, and Boyd Counties; the I-75 bridges in Fayette, Madison, Rockcastle, Laurel, and Whitley Counties; and the I-64 Riverside Parkway in Louisville.

This research has been the focus of national attention by the painting industry. Currently, KYTC has the lowest bridge painting costs in the United States. As a result of this cooperative research and development effort, the Transportation Cabinet has saved millions of dollars on its maintenance painting operations.

***Development of an Expert System for Assisting KYTC Personnel Concerning Environmental Issues***—The Environmental Analysis Section is working with KYTC officials to develop a knowledge-based information management software, Transportation Environmental Information Management System (TEIMS). When installed on the Cabinet's wide-area computer network, TEIMS will electronically process most information interchanges between the environmental divisions in the KYTC central offices and other divisions within the Cabinet.

TEIMS will provide environmental information, submission of permitting applications and reports, status inquir-

ies and technical assistance based upon specific inquiries for routine situations and incidents.

This expert system will aid the Cabinet in complying with an ever-growing body of laws and regulations and will provide a single, computer-based source of information interchange on environmental matters. A test version is being installed on a KYTC server for evaluation.

***Development of Procedures for Reducing Public Opposition to Highway Construction***—

While public opposition to roadway construction is not a widespread issue, it can disrupt budgeting and project scheduling. Opposition to road construction has arisen from landowners, environmentalists, and persons interested in historic preservation. The goal of this study is to provide KYTC with effective procedures for addressing public complaints about highway construction through improved dissemination of information and consensus building.

***Evaluation of the Service Performance of Bridge Components***—The deterioration of bridge components poses a maintenance expense to Kentucky taxpayers. Environmental Analysis Section staff are working with KYTC staff to review current and past generic bridge types to identify bridge components that are deteriorating at a rapid rate or that are otherwise subject to in-service problems such as a susceptibility to vandalism. Once the review is completed, remedial solutions will be recommended. Current designs may be modified to eliminate problems in future bridge designs. Also, remedial measures will be recommended for components on existing bridges to prevent further damage.

***Use of Recycled Rubber Tires as Lightweight Embankment Material***—Thousands of used automobile tires are discarded daily in Kentucky, and abandoned tire dumps are commonly found on new highway rights-of-way. The Environmental Analysis Section designed a highway embankment using chipped rubber tires and is monitoring the performance of this lightweight embankment material on the relocated US 27 currently under construction. The site has been instrumented to monitor subsequent settlement. The road and embankment will open to traffic in August 1997.

Tire chips appear to be an effective lightweight material to address specific embankment design problems and to allow the beneficial use of an environmentally troublesome material.

***Some research topics that have been addressed by the Center's Environmental Analysis Section***

- Formulation of specifications for environmentally compliant maintenance painting of steel bridges.
- Beneficial use of scrap tires in lightweight fills.
- Review of environmental practices of state highway agencies.
- Strain gaging of highway bridges.
- Fatigue analyses of steel bridges.
- Evaluation of various highway-related components and materials.
- Evaluation of protective coatings for steel.
- Development of computer-based expert systems.
- Evaluation of nondestructive testing methods for steel structures.

***Water-Based Heat Resistant Coatings***—The Department of the Navy is seeking a new high-temperature coating for shipboard applications that comply with strict environmental and worker safety regulations. The coating must perform satisfactorily at temperatures up to 1,000°F. This Section is working with a silicon resins manufacturer and a specialty paint firm to develop a water-based silicon coating with ceramic pigmentation-suitable coatings for those demanding applications. An experimental coating has been developed and is currently undergoing performance and industrial hygiene testing.

***Creation of a Regional State Highway Agency Working Group to Advance Bridge Maintenance and Inspection Practices***—State highway agencies of Indiana, Ohio, Wisconsin, Illinois, and Kentucky have formed the Midwest Bridge Maintenance and Inspection (BMI) Working Group to share cost and technical information in an effort to improve operational practices for bridge maintenance and inspection. Several meetings have been held at the Indiana DOT in Indianapolis. The Environmental Analysis Section is cooperating with the Infrastructure Technology Institute of Northwestern University, Evanston, Illinois, to develop the BMI Working Group and to adopt new mechanisms for information posting and exchange.

Major universities within those states have been asked to provide information about relevant research. An Internet-based home page and a bulletin board have been developed as information sources and mediums for discussions about bridge maintenance and inspection. They are currently under review by the BMI Working Group.

# Geotechnology

All highway facilities must be located on soil and rock materials. The Geotechnology Section conducts research on earthen materials that are used in the construction and maintenance of these facilities. It has been estimated that in mountainous areas, the cost of excavating and placing soil and rocks represents almost 90 percent of the contract price of building new highways. In flat and rolling terrain, this cost is estimated to be almost 50 percent of the contract price. Consequently, focusing research on soil and rock materials can provide large savings.

Research efforts have focused on methods of improving soil and rock materials of marginal engineering properties and the development of mathematical models and computer programs for analyzing and designing geotechnical structures. Personnel in the Geotechnology Section have developed specialized computer programs for analyzing the stability and bearing capacity of embankments, retaining walls, and pavements. A menu-driven program to store and retrieve geotechnical data from a statewide database containing numerous records has been developed and is maintained by the Section. The Section not only performs routine soil and rock testing but also performs very specialized testing of those materials.



*Findings from the Center's geotechnology research can help prevent rockfalls like this one that can block rural routes for several weeks.*

Current research activities involve:

- ◆ Determining resilient moduli of Kentucky soils and correlating moduli with other soil parameters, such as particle sizes, or plasticity indices.
- ◆ Determining amount and severity of bedrock scour and correlating bedrock scour with rock parameters, such as Rock Quality Designation and compressive strength.
- ◆ Improving computer programs used to analyze stability of embankments and retaining walls.
- ◆ Determining long-term strength and bearing capacities of stabilized subgrades.
- ◆ Performing rockfall analyses for the Kentucky Transportation Cabinet (KYTC).
- ◆ Determining the geotechnical properties and highway construction uses of by-products from coal-fired electric plants.
- ◆ Developing a soil and rock geotechnical data bank.

## Examples of some major implementation of the Center's geotechnology research

- Stabilization of clay subgrades to improve pavement performance.
- Methods to identify shales which degrade when used in construction.
- Demonstration of techniques for monitoring the movements of landslides and development of methods of designing remedial measures for correcting landslides.
- Development of design techniques for preventing instability and settlement of highway embankments.
- Developing special specifications for slaking and compaction of shale in highway embankments to reduce settlement and improve slope stability.
- Development of personal computer programs for analyzing the slope stability of embankments and retaining walls with and without reinforcement tensile elements.
- Identifying hazardous rock slopes and developing a rockfall management program.
- Developing design and construction techniques for minimizing the bump, or differential settlement, at the ends of bridges.

## Laboratory accreditation

The Center's geotechnical and aggregate laboratories received accreditation from the American Association of State Highway Transportation Officials (AASHTO) Materials Reference Laboratory (AMRL) in April 1997. Geotechnical accreditation was received for soil tests, and aggregate accreditation was received for concrete and asphalt aggregate tests. AMRL accreditation is received when an agency demonstrates proper testing procedures, equipment verification, technician training, participation in AMRL proficiency samples testing program, and developing and implementing a quality system program.

## Benefit-cost ratio of geotechnical research

Generally, the benefit-cost ratio of research performed by the Geotechnology Section ranges from approximately 2.5 to values exceeding 200. For example, the cost of repairing landslides on stretches of I-75 (Lexington to Cincinnati) and I-71 (Louisville to Cincinnati) has averaged about \$2 million per mile. Old compaction specifications treated the embankment materials (Kope and Fairview shales placed during the sixties and seventies) as rock and allowed them to be placed in three-foot lifts. Shale research, sponsored by KYTC and performed by this Section, revealed that these embankments settled because the loosely placed materials slaked when exposed to water. Eventually, many of those embankments failed.

Using shale compaction specifications formulated and recommended by Center geotechnology researchers, embankments were constructed on an 85-mile stretch of the Alexandria-Ashland Highway (KY 9). The researchers also recommended using milder slopes than those used on I-75 and I-71. Even though the same types of shales in the embankments of I-71 and I-75 were present in the embankments of KY 9, only two embankments on the 85 miles of KY 9 have shown movement since 1987.

Considering that the cost of repairs on I-71 and I-75 averaged approximately \$2 million per mile, the savings to the Cabinet is calculated to be approximately \$170 million. The benefit-cost ratio is calculated to be about 400.

## Research studies in progress

***Correlation of Observed Rock Scour with Preconstruction Rock Quality***—This study evolved as a result of a major bridge failure in New York State, as well as some other bridge failures in the country several years ago. The scour, or erosion, of materials supporting bridge foundations has been a major concern of the Federal Highway Administra-

tion and other governmental agencies. Because of this concern, a general belief has arisen that bridge foundations should be constructed at greater depths than those in the past to prevent the scour of materials supporting bridge foundations. However, this procedure would greatly increase costs of new structures as well as require retrofitting measures at existing bridges. Moreover, it has been proposed to perform scour analyses at approximately 8,000 bridges in the state at an estimated cost of \$3,000-\$6,000 per bridge. Results obtained to date indicate that performing scour analysis at every bridge in the state may not be necessary provided periodic observations are performed.

Geotechnology Section personnel developed an observational numerical rating system for evaluating rock scour at bridges where foundation elements can be visually inspected. This simple system is being used by a consulting firm that is assessing scour for KYTC. The system was developed earlier in the research study. Rock cores are being obtained at sites where rock scour is present and a correlation of Rock Quality Designation (RQD) and scour depth is being attempted. This correlation, if shown to be valid, will provide the basis for designing new bridge foundations on rock in Kentucky. The potential benefit-cost ratio of this study is estimated to be in excess of 200.

***Stress in Highway Pavement Subgrades and Relationships among Resilient Moduli and Soil Indices***—To use mechanistic pavement models in designing flexible pavements in the future, which is a goal of KYTC by the year 2002, it will be necessary for the Cabinet to perform resilient modulus testing for various soil types located in Kentucky.

Resilient moduli of various Kentucky soils are being determined using new state-of-the-art testing equipment and data-acquisition software.

Resilient moduli have been determined for soils compacted to subgrade specifications, hydrated lime-stabilized clays, cement-stabilized soils, and saturated clays. Resilient moduli are currently being determined for all roadway samples processed by the Cabinet's Division of Materials Geotechnical Branch. Various correlations of resilient modulus and California Bearing Ratio (CBR) are being developed so that the current system used to design flexible pavements can be compared to the new, mechanistic models.

Results of this study will play a significant role in the future, as well as the current, design of flexible pavements in Kentucky. The potential benefit-cost ratio of this study is estimated to be in excess of 100.

# Intelligent Transportation Systems

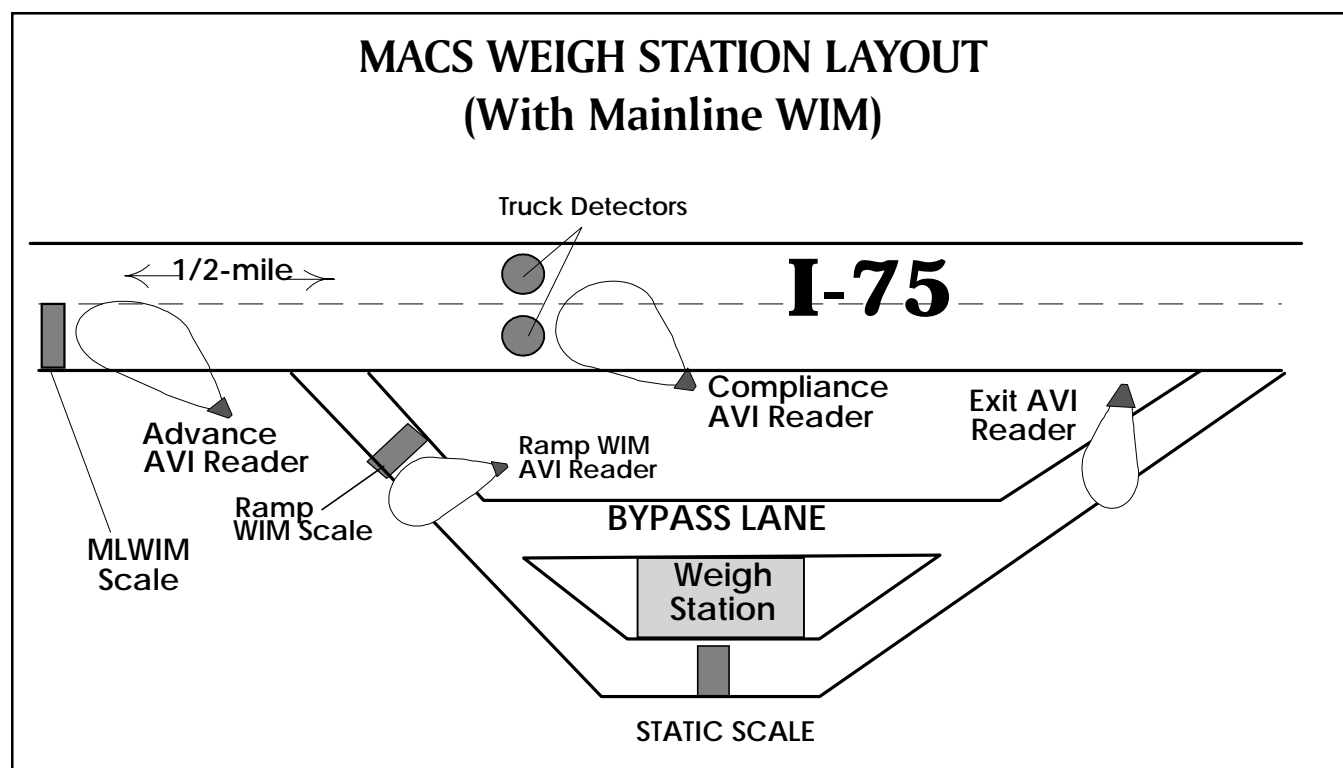
Intelligent Transportation Systems, or ITS, refers to the use of advanced detection, processing, and communications technologies to make transportation safer, more efficient, and less harmful to the environment. In recent years, the Center and the Commonwealth of Kentucky have become recognized as national leaders in the field of ITS. Since 1990, when the Center began providing staffing and management support for the *Advantage I-75* Operational Test Project, the Center's expertise and resources in the area of ITS have continued to grow. The Center now has a multidisciplinary staff of 10 individuals devoted to various ITS projects. The initial emphasis of the Center's ITS work was on applications of ITS to Commercial Vehicle Operations, but this has expanded to encompass other areas, including Advanced

Traveler Information Systems (ATIS), Advanced Traffic Management Systems (ATMS), Advanced Rural Transportation Systems (ARTS), and statewide strategic planning for all of ITS.

## Current ITS projects and programs

**Advantage CVO**—The Advantage I-75 partnership, now called **Advantage CVO**, is a partnership of public and private interests along the Interstate-75 corridor. The goal of the partnership, which was formed in mid-1990, is to reduce congestion, increase efficiency, and enhance safety of motorists and other users of I-75 (and its connections into Canada) using advanced vehicle and highway technologies. Kentucky is the lead state for the partnership and the Center provides project staff and serves as the project's Operations Center.

The project currently being conducted by the **Advantage CVO** partnership is an operational test of the Mainline Automated Clearance System, or MACS. The purpose of MACS is to identify a participating truck and check its weight and credentials while it is on the Interstate mainline, thus eliminating the need for it to pull through the weigh station. The primary technologies used are Automatic Vehicle Identification (AVI) and weigh-in-motion (WIM). Each participating truck has installed in the cab a transponder which is capable of two-way communication with roadside AVI read-





*ITS technologies are being used to enhance the efficiency and effectiveness of motor carrier enforcement at Kentucky's weigh stations.*

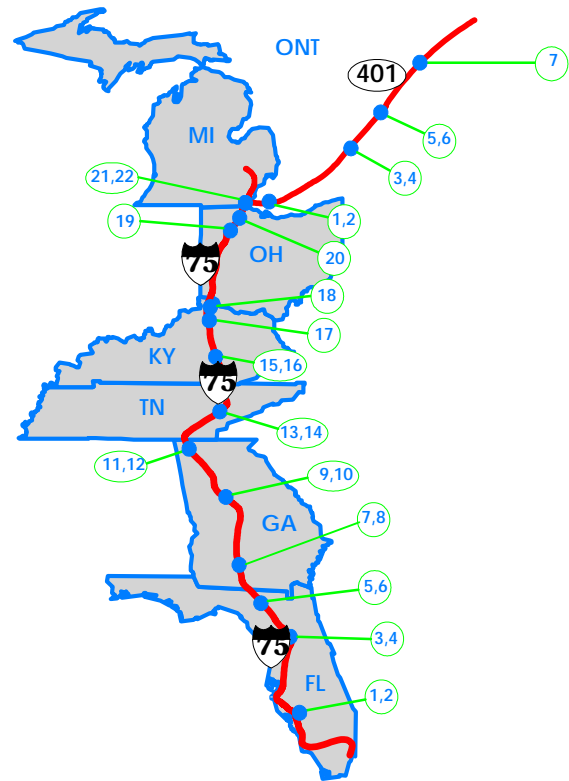
ers. Each weigh station has a reader installed approximately 1/2 mile in advance of the station, and an additional 2-3 readers in the weigh station complex (depending on the weigh station configuration). A participating truck, with legal weight and credentials, should not have to stop at more than one weigh station during a corridor trip. In fact, if the first station encountered has mainline WIM equipment, it is possible to have no stops during a trip.

MACS has been installed at all 22 weigh stations on I-75 from southern Florida to Detroit, and at an additional seven sites on Highway 401 in Ontario. Over 4,400 trucks, representing over 100 companies, are participating in the project. The two-year operational test officially ends on September 30, 1997, but the partner states have already agreed to fund continued operation of the system for at least one additional year. Enrollment of motor carriers is again underway, with a target of enrolling 65,000 trucks.

Weigh station stops are costly for truckers and, therefore, for the consumer who uses the product transported by truck. These stops result in non-productive time for the trucker, higher fuel consumption, and additional air pollution. The merging and diverging required at weigh station ramps creates a safety concern, particularly when long lines of trucks back up onto the mainline. By eliminating unnecessary and redundant stops, MACS results in lower costs, less fuel consumption, reduced exhaust emissions, and enhanced safety for all highway users. In addition, by recognizing carriers with good records and processing them on the mainline, enforcement personnel are better able to focus their attention on the "problem" carriers.

**Interstate 65 Electronic Clearance Project**—The Center is managing (for the Kentucky Transportation Cabinet and the Indiana DOT) an electronic clearance project for

## Advantage I-75 Corridor



*The circled numbers indicate weigh stations on the I-75 Corridor from Florida to Canada.*

commercial vehicles on Interstate 65. The system being installed for this project is simpler and less costly than that used for **Advantage CVO**, but the technology to be used for vehicle-roadside communications will be fully compatible, thus making any differences transparent to the users. The system will be installed at three northbound weigh stations (Franklin, Ky., Elizabethtown, Ky. and Seymour, In.) in early 1998 (see map on next page).

The system being installed on I-65 is intended to be a model for other states wishing to implement a simple, low-cost, electronic clearance system. The software and system design being used on I-65 will be made available for any states that wish to use them.

Electronic clearance on Interstate 65 will have the same types of benefits as the MACS installations on I-75. In addition, the simple, low-cost design of the I-65 system will en-

## I-65 ELECTRONIC CLEARANCE SITES



courage states to implement these systems at additional weigh stations and on other corridors. Such geographic expansion will increase the value to motor carriers, encourage greater enrollment, and cause the benefits to grow exponentially.

**CVISN**—Kentucky is one of seven model deployment states for “Commercial Vehicle Information Systems and Networks” (CVISN). CVISN is best described as a national architecture for ITS/CVO systems and services.

The focus of CVISN is broader than just processing trucks more efficiently at weigh stations. It covers every aspect of commercial vehicle administration and enforcement, from how a trucker applies for necessary credentials to how truck inspection data get uploaded to appropriate national databases. The CVISN architecture, when implemented, will make all aspects of commercial vehicle processes more efficient and more effective. Benefits will include cost savings and time savings to motor carriers, reduced administra-

tive load for carriers and state agencies, more accurate and timely data available for enforcement personnel, more effective identification (and removal from operation) of unsafe or illegal carriers, and improved sharing of data among states (for interstate carriers).

As a model deployment state, Kentucky will be deploying eight different user services over the next two years.

1. Distribution of safety information to computers at the roadside to target high-risk carriers.
2. Use of license plate readers at roadside to electronically identify commercial vehicles and carriers to check safety information.
3. Electronic collection of inspection data from the roadside and uploading to “SAFETYNET.”
4. Electronic application for credentials by motor carriers.



5. Interfacing of state systems to the International Registration Plan (IRP) clearinghouse.
6. Interfacing of state systems to the International Fuel Tax Agreement (IFTA) clearinghouse.
7. Electronic clearance at fixed and/or mobile sites.
8. A system for requesting oversize/overweight permits electronically.

The Center is working closely with the Kentucky Transportation Cabinet and the US Department of Transportation to achieve successful deployment of these services.

**ITS/CVO Mainstreaming**—The ITS/CVO Mainstreaming program is intended to promote nationwide deployment of ITS/CVO technologies and services by the year 2005. The specific objectives are to:

- ◆ Emphasize safety, clearance, and credentials activities.
- ◆ Encourage automation of networks and facilities that support ITS/CVO deployment consistent with the CVISN architecture.
- ◆ Establish the appropriate foundation for future integration and implementation towards CVISN architecture.

Kentucky was selected by the US Department of Transportation to conduct state mainstreaming activities and to



*A truck passes under an automatic vehicle identification (AVI) reader antenna in Ontario, Canada.*



*Mark Elam, system programmer and trainer, examines an automatic vehicle identification (AVI) reader cabinet in Georgia.*

serve as the lead state for two regional consortia of states. The consortia are as follows:

Southeast

Georgia  
Kentucky  
Mississippi  
North Carolina  
South Carolina  
Tennessee  
Virginia

Great Lakes

Indiana  
Kentucky  
Michigan  
Minnesota  
Ohio  
West Virginia  
Wisconsin

The Kentucky Transportation Center is serving in the role of “Regional Champion” for these consortia, providing planning, guidance, coordination, outreach, administration, and whatever other assistance is needed to accomplish the program objectives.

The Mainstreaming program will lay the groundwork for ITS/CVO technologies to spread beyond the CVISN Model Deployment states and be deployed throughout the country. As these technologies spread, the benefits will spread with them. As more and more states are able to implement the CVISN architecture, the benefits of safety, simplicity, and savings will be realized throughout the United States.

# Pavements

The Pavements Section conducts research and analysis in many areas of the pavements industry. Highlights of the past year's research and activities include:

- ◆ Seismic evaluation of bridges on US 51 near Wickliffe, Ky., and on US 41 in Henderson, Ky.
- ◆ Section personnel taught workshops on Pavement Management Systems.
- ◆ Section personnel completed an evaluation of highway retaining structures.
- ◆ Conducted a structural evaluation and overlay design of US 27/KY 80 intersection in Pulaski County.
- ◆ Conducted a number of other pavement structural evaluations for various agencies.
- ◆ Employed two engineers-in-training (EITs) full-time to assist in Section activities.
- ◆ Continued preparation for AASHTO Asphalt Laboratory Certification.
- ◆ Initiated laboratory testing of rigid pavement joints.

## Research studies in progress

***Development of a Rigid Pavement Design and Maintenance System for Kentucky Conditions***—The objective of this project is to evaluate the stresses and strains of portland cement concrete pavements under Kentucky conditions. The project involves both computer modeling of the pavement structure and instrumentation of actual pavements in service. The models developed during this study will assist the Cabinet in implementing the 2002 AASHTO Pavement Design Guide currently under development.

***Economic Impact of Heavy Loads on the Highway Infrastructure***—This study is evaluating the increased cost associated with rehabilitation, maintenance, and construction of highways used for transporting heavy loads. The results from this project will provide valuable information nec-

essary to evaluate any proposed changes in size and weight legislation which may occur.

***Network Life-Cycle Analysis System for Multi-Year Prioritization of Pavement Projects for Budget Optimization***—This project is developing a methodology to permit the application of standard alternates of rehabilitation and maintenance to a highway network. These standard alternates will be used to optimize pavement performance for the highway network with limited funding for a given budget period. This will permit the optimum use of available funding to achieve the desired level of service for the highway system.

***Evaluation of Intersection Rehabilitation, US 27, Pulaski County***—Center personnel performed evaluations of the existing pavement structure to determine the required structural overlay needed for rehabilitation. In addition, an analysis was performed to determine the optimum thickness of milling and overlay to reduce rutting of the intersection. Subsequent evaluations will be performed once the project is completed. The proposed rehabilitation currently is to



*Center personnel conduct structural field evaluation of bridge on I-64 in Morehead prior to the addition of concrete overlay. Trucks are used for static load testing on the structure.*

overlay one half of the intersection with a high-performance, rut-resistant, hot-mix asphalt while using a portland cement concrete overlay on the remaining half.

***Evaluation of Long-Term Performance of Wall Systems***—This study evaluated approximately 100 retaining structures. Distress and performance information have been



*Center personnel mounting reusable strain gages in preparation for load testing of concrete bridge decks.*

analyzed and compiled into a summary report. This information will be invaluable in the evaluation of current design standards for wall systems.

### ***Field Evaluation of Highway Edge Drains and Cross Drains***

***Pavement edge drain evaluations***—Several projects evaluating pavement edge drains are currently underway or

#### ***Some research topics that have been addressed by the Center's Pavements Section***

- Pavement management systems
- Pavement drainage systems
- Pavement structural analysis, including Falling Weight Deflectometer analysis
- Traffic data analysis
- Analysis of vehicle weighing devices
- Economic analysis of heavy loads on highway structures
- Performance monitoring of highway structures
- Hot mix asphalt and portland cement materials testing
- Field and laboratory instrumentation

have been completed. The evaluations were conducted using fiber optic scopes and a miniature pipeline inspection camera. These evaluations have included post construction inspections, performance studies, and evaluation of corresponding pavement and edge drain failures. Information derived from the edge drain inspections is currently being used to modify existing edge drain specifications.

***Cross drain evaluations***—Several cross drains were evaluated in areas of unstable embankments and sinkholes. A pipeline inspection camera was used to evaluate the cross drains. Several types of distress were observed during the evaluations. Distress included: joints separated, collapsed pipes, broken or deteriorated joints, and plugged pipes. It was evident from the inspections that the failures in the cross drains were causing additional distress at the surface.

***Evaluation of Road Weather Information Systems***—An evaluation is currently underway jointly with the Traffic and Safety Section to evaluate the effectiveness of five Road Weather Information Systems (RWIS) across the state. These systems will provide real-time information on roadway conditions during winter weather, allowing Cabinet officials to better utilize manpower and physical resources to maintain safe travel conditions.

*Center technologist connects strain gage equipment to computerized data acquisition system for structural evaluation of bridge deck overlay.*



# Structures

The research activities conducted in the Structures Section focus primarily on highway bridges and fiber-reinforced polymer (FRP) composites for infrastructure applications. Current research includes the following:

- ◆ Design and construction of FRP structures
- ◆ Bridge decks reinforced with FRP rebars
- ◆ Full depth bridge slab overlay
- ◆ Structural evaluation of the Roebling Bridge
- ◆ Influence of diaphragms on prestressed concrete bridges
- ◆ Vessel and truck impact on bridges
- ◆ Seismic rating of highway structures.

Accomplishments from the past year include:

- ◆ Construction of the world's longest FRP girder bridge in Daniel Boone National forest.
- ◆ Preliminary analysis and design of an FRP sonar rail system and equipment platform for the Coastal Systems Station at the Naval Surface Warfare Center in Panama City, Florida.
- ◆ Construction and testing of bridge deck segments reinforced with FRP rebars.
- ◆ Generated dynamic site periods due to earthquakes in Western Kentucky. Seismic assessment of highway embankments, and seismic evaluation of the US 41 and US 51 truss bridges over the Ohio River is continuing.
- ◆ Assessment of the influence of diaphragms in prestressed concrete bridges is continuing.



*Clear Creek Bridge, Daniel Boone National Forest, Bath County, Kentucky.*

Since the turn of the twentieth century, research has always played a vital role in advancing our transportation system. The value of research has manifested itself in safer modes of transportation and highly cost-effective investments of the public funds. Research in the structures area has led to the transfer of advanced composites technology to infrastructure applications. This new material will be one of the construction materials in the twenty-first century. Furthermore, seismic research and vessel and truck impact studies will lead to safer bridges in the state and in the nation.

## Research studies in progress

### *High-Performance Composite Material Structures—*

The Center, in partnership with the Great Lakes Composites Consortium (GLCC) in Columbia, S.C., and the Basic Industry Research Laboratory (BIRL), located at Northwestern University in Evanston, Illinois, was involved in the design and construction of the Clear Creek Bridge, the longest fiber-reinforced polymer (FRP) girder bridge in the world. This 60-foot pedestrian bridge is made totally out of lightweight composite materials and is located in the Daniel Boone National Forest near Cave Run Lake in Bath County.

The development, testing, design, and construction of the FRP Clear Creek Bridge are milestones for the transfer of advanced aerospace composites to infrastructure applications, and are steps toward the construction of short-span, vehicular, I-girder, FRP bridges in the near future.

### *Non-Magnetic, Synthetic Aperture Sonar Rail System and Equipment Platform—*

This project is investigating the use of advanced composite materials in an equipment platform for acoustic testing at the Coastal Systems Station of the Naval Surface Warfare Center in Panama City, Florida. All components are restricted to be nonmagnetic, and preferably nonferrous. Fiber reinforced polymer composites provide the required strength and satisfy the material constraints. This project illustrates the value of research by transferring aerospace technology to infrastructure applications leading to an economical solution to a complex construction project.

### *FRP Reinforcing Bars in Bridge Decks—*

Corrosion of steel reinforcement in concrete structures has been a persistent problem in exposed structures. This problem is particularly evident in reinforced concrete bridge decks subjected to a marine environment or de-icing chemicals. Furthermore, the great number of freeze-thaw cycles hastens the onset of corrosion related damage to bridge decks, even those constructed with epoxy-coated steel rebar. One solu-

tion is the use of corrosion-resistant, fiber-reinforced polymer (FRP) rebars which can perform in exposed environments without damage. Research into the use of FRP rebars in bridge decks will provide the technical data to effectively transfer this space age material into Kentucky's bridges.

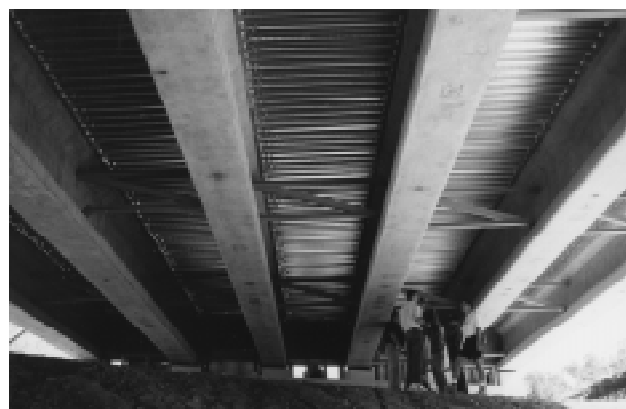
The results of the project will help develop design guidelines for the use of fiber-reinforced composite rebars in new and existing bridge decks. The fiber-reinforced composite material has the potential to solve the corrosion problems of conventional epoxy-coated reinforcement, and to decrease life-cycle costs.

**Full Depth Bridge Slab Overlay**—Kentucky has utilized a highly cost-effective, full-depth bridge slab overlay on approximately 25 bridges. Field evaluation of this innovative approach has not been conducted to date. The objective of this study is to evaluate the structural effects of full-depth slab overlays on Kentucky's bridges and their viability as a method of rehabilitation for other bridges. To achieve these objectives, two bridges on I-64 will be tested before and after construction of the full-depth slab overlay.

The expected benefits lie in verifying that a full-depth slab overlay reduces overall project costs and enables bridge load capacities to be increased without the need of expensive slab and girder replacement. Increased bridge capacity will result in improved load ratings which could avoid unnecessary posting or rehabilitation.

**Structural Evaluation of the Roebling Bridge**—A unique collaborative effort between Kentucky and Ohio is underway to preserve the Roebling Bridge for future generations to cherish. The bridge links the two cities of Covington and Cincinnati, and provides the focal point for much of the commercial and recreational expansion vital to the riverfront development on both sides of the Ohio River. This study will assess the response of the bridge to current and projected traffic loads. The study involves a detailed field testing and modeling of the bridge in order to generate "signatures." These "signatures" will be the basis for future evaluations and retrofits. This research will assist in the preservation of the Roebling Bridge, which is regarded by many as a national treasure.

**Bridges With and Without Diaphragms**—The objective is to investigate the cause of concrete spalling on the girder flange near the interface of the prestressed I-girders and the concrete intermediate diaphragms. The effectiveness of the concrete intermediate diaphragms will be evaluated to determine if they are performing as intended and



*Inspection of a prestressed concrete I-girder bridge with temporary steel diaphragms on US 23 in Johnson County.*

whether or not they may be omitted in future bridges. Similar bridges along coal-haul routes have experienced unusual distress at the interface of the intermediate diaphragms and girders.

Experimental and analytical investigations will ascertain if the intermediate diaphragms are performing as intended. If not, their elimination in future bridge projects could result in a significant reduction in the construction and maintenance cost of a bridge.

**Lifetime of Bridges Susceptible to Vessel and Truck Impact**—This study will develop risk assessment models to determine the probability and the associated dynamic impact energies of vessel and truck impact with bridges. Rational transient loading functions are being generated to perform realistic dynamic modeling for different soil configurations and types of foundations. Recommendations for probability-based vessel and truck impact design of highway bridges will be provided. This study will lead to rational and more realistic design guidelines and methodologies for bridges susceptible to vessel and truck impact. This in turn will lead to safer bridges.

**Seismic Rating and Evaluation of Highway Structures**—Research into the seismic stability of bridge approach embankments and selected truss bridges crossing the Ohio River in western Kentucky is underway. The objectives are to generate dynamic site periods due to seismic loading, conduct seismic stability assessments of highway bridge approach embankments and retaining structures, and perform seismic evaluations and analyses of the selected truss bridges. The findings of this study will enable engineers to accurately assess and evaluate highway structures, and will guide them in the design of new bridges and the seismic retrofit of existing bridges in Kentucky.

# *Traffic and Safety*

Traffic and safety research has the potential of providing significant benefits to the driving public in the form of improved safety and reduced accident rates. For example, the Center's involvement in promotional campaigns and evaluation to establish the benefits of safety belt usage were important in the passage of safety belt laws in Kentucky. Annual accident cost savings of \$300 million could be realized from reduced deaths and injuries (175 fatalities and 1,100 injuries) associated with increasing safety belt usage from 58 to 70 percent.

Safety and operational guidelines also have been established as a result of research related to heavy trucks, traffic control devices, pavement marking materials, and safety barriers such as guardrails and crash cushions.

Recommendations have been made to other state agencies to allow them to direct their funding to the appropriate areas with higher potential for safety benefits.

The Traffic and Safety Section has traditionally focused on research and training in a wide range of areas. Accomplishments from the past year include:

- ◆ Continued assistance with implementation of Kentucky's safety management system.
- ◆ Completion of a study to evaluate procedures for determining speed limits.
- ◆ Continued evaluation of traffic control devices at the Clays Ferry Bridge reconstruction project.
- ◆ Presentation of workshops on emergency response procedures to improve roadway clearance times.
- ◆ Completion of a report on traffic flow and safety of Fayette County school sites.
- ◆ Completion of a report on Lexington incident management techniques.
- ◆ Continuing activities for the Kentucky State Police related to development of accident rates and safety belt evaluation.

Although research has been the primary function of the Traffic and Safety Section during the past year, staff from the Section have served as instructors or have participated in several workshops, seminars, and conferences in the following subject areas:



*Advanced technology applications are used for travelers' safe passage through Cumberland Gap Tunnel. Included are closed-circuit camera and changeable message signs, with AM and FM radio for emergency broadcast.*

- ◆ Safety features for local roads and streets
- ◆ Work zone traffic control
- ◆ Roadway signs and markings
- ◆ Tourist signing
- ◆ Traffic accident investigation
- ◆ Coal truck driver safety training
- ◆ Roadway incident emergency response
- ◆ Tort liability

## **Research studies in progress**

**Safety Management System**—The Safety Management System provides a forum for cooperative exchange and dissemination of safety information to all participants in safety in Kentucky.

Subcommittees were formed and actions were taken which resulted in several accomplishments during the year related to the driver, vehicle, and roadway. Among the most significant first-year results was passage of legislation to implement a graduated licensing program in Kentucky. Ideas

### ***Some research areas that have been addressed by the Center's Traffic and Safety Section***

- Evaluation of highway safety features
- Accident analysis and investigation
- Traffic forecasting
- Highway planning
- Analysis of traffic control devices and operational features
- Evaluation of roadway delineation devices and materials
- Review and analysis of incident management procedures
- Traffic safety management evaluation



*Technicians who monitor the closed circuit cameras for emergencies can notify motorists of any hazards or delays at the Cumberland Gap Tunnel.*

were exchanged and concepts for safety management priorities were set with the following areas identified for future activity: 1) comprehensive community safety programs, 2) driver retesting, 3) DUI legislation, 4) emergency medical services enhancements, 5) high school driver safety program, and 6) voluntary vehicle inspection programs.

***Evaluation of Procedures for Determining Speed Limits***—A study was completed which examined current criteria and procedures for setting speed limits on Kentucky roads and recommended procedures based on safety and compliance considerations.

Recommendations were made for a uniform procedure for setting speed limits which should result in an increased level of compliance.

Results from this study can be used as guidelines for recommendations to the Legislature in establishing appropriate speed limits on various types of Kentucky's roadways.

***Condition-Responsive Traffic Control Devices at Clays Ferry Bridge***—To enhance safety during reconstruction of the Clays Ferry Bridge, several applications of advanced technologies for real-time control and management of traffic through the work zone have been implemented. Included are video surveillance cameras, changeable message signs, highway advisory radio, motion detection devices, and a weather monitoring system. The system will continue to be monitored and a final report on the traffic control devices will be completed at the end of the construction project in 1998.

A separate study of the weather system at Clays Ferry Bridge and other sites in Kentucky is also underway.

Information obtained through evaluation of the advanced traffic control systems will be applied to similar

projects. Weather data also will be provided to the driving public through various media sources and to maintenance personnel as advance information for winter operations.

***Emergency Response Procedures to Improve Roadway Clearance Times***—An evaluation was conducted of processes and procedures for emergency response to incidents and accidents on Kentucky highways. Results were included in the development of a workshop which focuses on the benefits from improvements in the investigation and clearance procedures.

Workshops have been conducted at several locations to promote the benefits of improved roadway clearance. Legislation has been drafted for consideration during the 1998 Legislature which would enable rapid removal of vehicles from roadways after accidents.

***Extended-Weight Coal Haul Road System***—A final report was prepared which updated some of the analyses and results included in the interim report. The primary recommendation was that the extended-weight system should evolve into a comprehensive trucking network, with all trucks hauling commodities treated similarly.

Results from this evaluation have been used as the basis for re-examination of the extended-weight concept and alternatives are being considered by the Kentucky Transportation Cabinet (KYTC).

***Safety Projects for the Kentucky State Police***—Traffic accident statistics were compiled for Kentucky roads for the period 1990-1994. Data were used for traffic safety problem areas for use in preparation of the Annual Highway Safety Plan. Safety belt usage surveys were conducted for the fourteenth year, with the results showing a 55-percent overall usage rate in 1996.

The accident data developed in this study serve as the basis for the high-accident location program administered by KYTC and the problem identification portion of Kentucky's Highway Safety Plan.

***Field Evaluation of Pavement Marking Materials***—Pavement marking materials (traffic paint, thermoplastic, permanent tape, removable tape) were placed on test decks and evaluated. The evaluation includes reflectivity, durability, and appearance.

The data provided in this study are used by the states nationwide to determine the types of pavement marking materials to use on their highways.

# *Southern Kentucky Corridor (I-66) Study*

The Transamerica Corridor Study, often referred to as I-66, was authorized by the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). The study was conducted by several large national consulting firms that investigated several optional systems for the transportation of people and goods across the United States from Hampton Roads in Virginia to Southern California. The results of the national study indicated that an interstate highway or new accessibility corridor (traditional interstate highway, high-speed truckway, high-speed rail, etc.) was not economically justified or financially feasible at this time, but segments of the system may be economically justified.

This statement regarding possible justification of system segments prompted one of our congressional delegates and the Kentucky Transportation Cabinet to solicit funding from the U.S. Department of Transportation. Kentucky was approved for funding a study to determine the economic justification and financial feasibility of the Kentucky segment of the Transamerica Corridor (Interstate 66).

The Kentucky segment study was initiated in the summer of 1995 by a joint agreement between the Kentucky Transportation Cabinet and the Center. The study scope and name (Southern Kentucky Corridor) were approved and the work got underway in fall 1995.

The study was finalized with issuance of the final report "Southern Kentucky Corridor, I-66, Economic Justification and Financial Feasibility," May 1997.

This study included the following major components:

## ***Existing inventory and highway options and costs—***

This phase of the study involved an inventory of the existing highway system in the Southern Kentucky Corridor (SKC) and a compilation of existing socioeconomic data (population, employment, income, etc.) and a forecast of the horizon year socioeconomic data (year 2025) for the new corridor. A report on the existing conditions was published

and the cost of the three SKC (I-66) design options has been developed by the University of Kentucky Department of Civil Engineering.

***Statewide traffic model--Years 1995 and 2025—***A national consulting firm was awarded the contract to develop a regional traffic model that would simulate existing travel conditions and the year 2025 travel conditions for both auto and truck trips. Travel estimates are considered preliminary due to the condition that the future traffic assignments to the new SKC (I-66) will stimulate economic growth in the corridor and will result in population and employment increases. Socioeconomic increases result in increased corridor traffic. This increased corridor growth will be reflected in revised traffic assignments by the end of 1996.

***Econometric model—***The University of Kentucky Center for Business and Economic Research (CBER) was responsible for modeling the relationship between increased corridor accessibility with the SKC (I-66) project and economic stimulation.

***Economic analysis—***To determine if a highway improvement is economically justified, the economist applies such tools as benefits versus cost analysis with appropriate discount rates to bring future costs and benefits to present-day values.

The CBER, by using the travel summaries resulting from the travel model was able to calculate the road user benefits of the proposed SKC (I-66) corridor improvement. At a 4-percent discount rate, the route improvement is considered to be economically justified.

***Study conclusions—***The construction of the Southern Kentucky Corridor using a normal 70 mph interstate design speed and either the Alternate A or B alignment in Western Kentucky through Paducah and Wickcliffe would cost approximately \$5 billion. Building the roadway would deliver substantial economic development and quality-of-life benefits to this economically distressed region. The economic analysis indicates that employment gains of around 55,000 jobs per year could be created by the construction of I-66 through Southern Kentucky. In addition to economic gain, the interstate-type roadway would also save approximately 250 lives during the first 20 years of the project because of improved design standards. Therefore, Alternate A or B using the 70-mph design option would be preferred from a benefit-cost economic development, and financial justification perspective.



## ***Southeastern Transportation Center (STC)***

# ***Advanced Transportation Institute***

The University of Kentucky's involvement in this special program is now in its eighth year. It has provided over 50 fellowships to UK graduate students interested in transportation. These students are drawn from business administration, civil engineering, geography, and public administration.

The purpose of the Institute is to produce highly skilled and knowledgeable transportation professionals needed to meet current and future mobility and safety challenges.

The program provides the students with a special focus on transportation safety and experiential opportunity. In addition, they are challenged to think transportation systems and experience interdisciplinary teamwork.

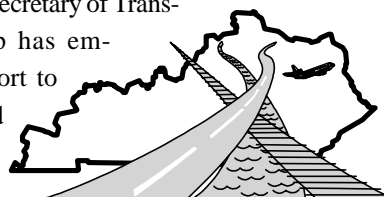


Students take two special courses—one on intermodal transportation safety and the other on transportation management/administration challenges.

As part of a larger group of graduate students in the Southeast, these students attended the Transportation Research Board's annual meeting in Washington, D. C.

## ***Intermodal Studies***

Kentucky's Intermodal Advisory Panel (IAP), a group representing all modes and forms of transformation, was established to advise the Secretary of Transportation. This group has embarked on a major effort to identify problems and opportunities within each mode and those shared among the modes. The Center supplements the staff of the Kentucky Transportation Cabinet's Division of Transportation Planning in support of the IAP.



Early in 1997, the IAP presented the results of a year-long effort to identify the key areas of attention in the Kentucky transportation system. "A Kentucky Transportation Vision" detailed major recommendations to the Transportation Cabinet, and a plan for pursuing those recommendations. The Center staff plans to support the realization of these recommendations through research, advice, facilitation, and collaboration among intermodal partners.

In a specific response to those recommendations, the Center is now expanding the capabilities of the Intermodal (IM) Database, a Geographic Information System database containing location, contact, and access information about Kentucky's intermodal systems. The IM Database will, in the coming year, be made more user-friendly through web-enabling of many of its database and GIS functions. This in turn will augment the quality of the information in the IM Database, as users can more readily review and verify the accuracy of the information contained therein.

## *Special Projects & Other Research*

The Special Projects Section works in conjunction with other sections to perform quick response studies, product evaluations, unforeseen investigations, and to oversee long-term monitoring on experimental or non-conventional projects. The Section is responsible for the maintenance of all technical records, preparation of biannual and status reports, and the annual work program. Section staff assist other units within the Center in development of software, data collection and management, and maintenance of computer hardware. The Information Systems Branch provides computational technical assistance to other sections and assists in data storage and maintenance.

The long-term monitoring study consists of 27 subtasks. During the year, data were collected on the following subtasks:

- ◆ Pavements joints and seals
- ◆ Subdrainage and edge drains
- ◆ Cracking and reflective cracking
- ◆ Long-span and box culverts
- ◆ Structural paint systems
- ◆ Plastic pipe
- ◆ Guardrail end treatments
- ◆ Roadway delineation
- ◆ Calcium nitrite decks
- ◆ Big stone mix
- ◆ AA highway
- ◆ Paint removal
- ◆ Chemical subgrades
- ◆ By-products
- ◆ Breakaway poles
- ◆ Wall systems

This Section coordinates product evaluation for materials and concepts assigned to the Center for study by the Products Evaluation Committee of the Kentucky Transportation Cabinet (KYTC). Recent evaluations have included:

- ◆ Bridge earthquake isolation systems
- ◆ Concrete deck sealing systems

- ◆ Findrain configurations
- ◆ Structural paint formulations
- ◆ Polyethylene pipe
- ◆ By-product utilization
- ◆ Pavement markers
- ◆ Energy absorbing systems
- ◆ Retroreflective sheeting

The Information Systems Branch acts as a liaison between the Center and the Engineering Computing Center to maintain, troubleshoot, and enhance the network capabilities of the Center. It is responsible for installation and maintenance of network hardware and software on Center computers.

The staff also works with the Network Services at the Kentucky Transportation Cabinet to allow the Center access to information and data on the Frankfort mainframe and various servers in KYTC.

The Section is responsible for the system administration for a multi-user Unix system. This includes setting up and maintaining user accounts and groups, adding software, system backup, and disk maintenance.

Other duties of the Information Systems Branch include developing new programs, maintaining and updating existing programs, developing and maintaining the Center's home page on the Word Wide Web, and installing, training, assisting, and troubleshooting PC software for the Center's staff.

### **Value of research**

As technology advances, there is a continually increasing number of unique or innovative approaches used as experimental features in transformation design, construction, or maintenance phases of the systems. Provisions are generally made for short-term evaluations of experimental features; however, most formal studies or projects are frequently finalized in rather nominal time periods and no provisions are made for long-term evaluations. Long-term evaluations provide significantly important information at relatively nominal costs.

Unforeseen investigations and quick response studies provide a means of responding to situations requiring immediate attention. These studies generally provide solutions to pressing problems in a timely manner so that work on the project may continue without undue delay. Many times, unique solutions are provided for difficult problems. The benefit-cost ratios for these studies are normally high.

## ***Construction Related Research Projects***

Members of the Construction Engineering and Management Area of the Civil Engineering Department are currently conducting four construction-related research projects for the Kentucky Transportation Cabinet (KYTC). A project entering its fifth year is the development of a conceptual cost estimating model for use in setting the initial cost budget for new KYTC projects when initiated in the Six-Year Plan. The current system has drawn much concern in the Legislature since so many projects cost more than their original budget. A user-friendly computer model has been developed for District personnel based on historical cost records of past KYTC construction projects. Continuing efforts are concentrating on the strengthening of the databases with more historical costs, plus training sessions are being held with District personnel.

A second project was completed to determine the general location and an estimate of the roadway costs of a South-

ern Kentucky Corridor (see page 28) that connects I-55/I-57 in Missouri with I-81 in Virginia. The total route length of this Southern Kentucky Corridor is approximately 610 miles, with 420 miles in Kentucky. Cost estimates were developed for three alternative highway designs: an Arterial/Freeway - 60 mph; a conventional Interstate - 70 mph utilizing interstate highway-type design; and a High Speed Interstate - 80 mph utilizing a roadway design that encourages higher speeds to attract long-haul travel and commodity flow.

A third project was completed concerning the scheduling requirements for KYTC construction projects. A sample specification was developed for requiring appropriate schedules of contractors on all KYTC projects, including the required use of Prima Vera project scheduling computer software. Finally, a training program and workbook on Critical Path scheduling techniques was developed and four workshops were conducted for KYTC project personnel. Final recommendations included a suggestion to develop a scheduling system for all phases of a KYTC construction project: planning, design, contract award, and construction.

A fourth project was initiated in mid-year to evaluate the innovative contract methods being used on the Paris Pike reconstruction project from Lexington to Paris, Kentucky. A study will be made of the final results achieved on the project and compared to results typically attained on KYTC construction projects performed under the traditional design-bid-build method. This project is one of the most unique highway construction projects ever built in Kentucky.

**Thousands of used automobile tires are discarded in Kentucky every day. Researchers in the Environmental Analysis Section at the Transportation Center have designed a highway embankment using chipped rubber tires and are monitoring its performance on the relocated US 27 currently under construction.**



*Tire chips like these appear to be an effective lightweight materials to use as embankment material.*



*Highway embankment being constructed using recycled rubber tires.*

# ***Research Reports—1995 thru 1997***

## **1997**

KTC-97-15	Summary of Results of 1995 Field Evaluations of Long Life Pavement Marking Materials
KTC-97-14	Legislation Review and Recommendations to Reduce Evasion of Kentucky Road Fund Revenues
KTC-97-13	Cost Estimating and Forecasting for Highway Work in Kentucky
KTC-97-12	Report on County Road Finance
KTC-97-11	Visual Inspection of Keystone Block Wall and Embankment Side at Mist Lake Plaza in Lexington, Ky.
KTC-97-10	Evaluation of Wall Structures in Kentucky
KTC-97-9	Examination of Concrete Cores from Lowe's Store in Carbondale, Illinois
KTC-97-8	Subsurface Drainage of Highway Pavements
KTC-97-7	Roadway Related Tort Liability and Risk Management (4th Edition)
KTC-97-6	Evaluation of Speed Limits in Kentucky
KTC-97-5	Performance and Cost Effectiveness of Pavement Edge Drains
KTC-97-4	Traffic Flow and Safety Evaluation of Fayette County Schools - Part II
KTC-97-3	Performance Evaluation of Recycled PCC Pavement Used as a Dense-Graded Aggregate
KTC-97-2	Analysis and Design of Bridges Susceptible to Barge Impact
KTC-97-1	Dynamic Site Periods for Jackson Purchase Region of Western Kentucky

## **1996**

KTC-96-31	Applicability of Angle Parking for a Major City Street
KTC-96-30	Evaluation of SHRP Work Zone Safety Devices
KTC-96-29	Evaluation of Red Light Running Campaign
KTC-96-28	Survey of High School Driver Safety Programs
KTC-96-27	Evaluation of a Regional Safety Improvement Program
KTC-96-26	Evaluation of Lexington Incident Management Techniques
KTC-96-25	Use of Audible Pedestrian Signals
KTC-96-24	Visual Inspection of New Ramp Pavement at Bluegrass Airport, Lexington, Kentucky
KTC-96-23	Rubberized Asphalt Membrane
KTC-96-22	Analysis of Traffic Accident Data in Kentucky (1991-1995)
KTC-96-21	Traffic Flow and Safety Evaluation of Fayette County Schools
KTC-96-20	1996 Safety Belt Usage Survey and Evaluation of Effectiveness in Kentucky
KTC-96-19	Evaluation of Portable Retroreflectometers
KTC-96-18	Summary of Results of 1995 Field and Laboratory Evaluation of Pavement Marking Materials
KTC-96-17	Evaluation of Edge Drains on Interstate 64, Fayette, Scott, and Woodford Counties
KTC-96-16	The Motor Fuel Tax Evasion Issue in Kentucky
KTC-96-15	Development of a Critical Path Method (CPM) Specification and a Training Program for Use of CPM for the Kentucky Transportation Cabinet
KTC-96-14	Cost Estimating and Forecasting for Highway Work in Kentucky
KTC-96-13	Development of Accident Reduction Factors
KTC-96-12	Evaluation of Edge Drains on I-81 in Roanoke, Virginia
KTC-96-11	Evaluation of Edge Drains on Pennyrile Parkway, Webster County

KTC-96-10	Evaluation of Superior Performing Portland Cement Concrete Pavements in Kentucky
KTC-96-9	Rockfall Mitigation Measures
KTC-96-8	A Proposed Method of Calibration and Correlation of Weigh-in-Motion Systems
KTC-96-7	Environmentally Safe Protective Coatings for Steel Structures—New Construction Maintenance Painting
KTC-96-6	Notes on Seismic Analysis and Retrofit of Bridges
KTC-96-5	Seismic Evaluation of Highway Bridges in Kentucky
KTC-96-4	Source Zones, Recurrence Rates, and Time Histories for Earthquakes Affecting Kentucky
KTC-96-3	Evaluation of Geogrid-Reinforcement Roadbed in Barren County
KTC-96-2	1996 Highway Cost Allocation Update—Summary and Overview
KTC-96-1	1996 Highway Cost Allocation Update

## **1995**

KTC-95-25	Impacts of Extended Weight Coal Haul Road System
KTC-95-24	PC Program for Reinforced Embankment Stability Analysis
KTC-95-23	Guidelines for the Installation of Left-Turn Phasing
KTC-95-22	Preliminary Assessment of Local Scour Potential at Bridge Piers and Abutments Founded on Rock
KTC-95-21	Use of Class AA Concrete Modified with a High-Range Water Reducing Admixture in a Full-Depth Bridge Deck Slab, US 127, Lincoln County
KTC-95-20	1995 Safety Belt Usage Survey and Evaluation of Effectiveness in Kentucky
KTC-95-19	Analysis of Traffic Accident Data in Kentucky (1990-1994)
KTC-95-18	Pavement Distress at Intersections
KTC-95-17	Ballast Size for Safe Working Conditions in Railroad Yards and Terminals in Kentucky
KTC-95-16	Summary of Results of 1994 Field and Laboratory Evaluations of Pavement Marking Materials
KTC-95-15	Toward Determining Minimal/Optimal Transportation Department Resources Requirements—An Examina- tion of State Privatization Trends Among Selected States
KTC-95-14	Best Practices for Commercial Vehicle Monitoring Facilities Design
KTC-95-13	A Life-Cycle Cost Analysis Program for Kentucky Pavements
KTC-95-12	Cost Estimating and Forecasting for Highway Work in Kentucky
KTC-95-11	Preliminary Evaluation: ARTIMIS Reference Point Signs
KTC-95-10	Evaluation of Aquaron Concrete Treatment Products (2000 CPT, 2000 curve and seal, and 7000)
KTC-95-9	Performance of Pyrament Cement Concrete in a Highway Bridge Deck
KTC-95-8	Performance of Shrinkage Compensating Bridge Deck Concrete (Class S), I-75, Kenton County
KTC-95-7	Equivalent Single Axleload Computer Program Enhancements
KTC-95-6	Development of an Alternate Methodology for Identifying Heavy Coal Trucks and Calculating ESALs/Axle and Axles/Truck
KTC-95-5	Development of a Safety Management System
KTC-95-4	Roadway Related Tort Liability and Risk Management
KTC-95-3	Toward Determining/Optimal Transportation Department Resource Requirements: An Examination of State Privatization Trends Among Selected States
KTC-95-2	Field Performance Report on PVC Pipe, Campbell County
KTC-95-1	A User's Guide for By-Product and Discarded Material Utilization in Highway Construction and Mainte- nance

# ***Expenditures Statement***

**FY 1996-97**

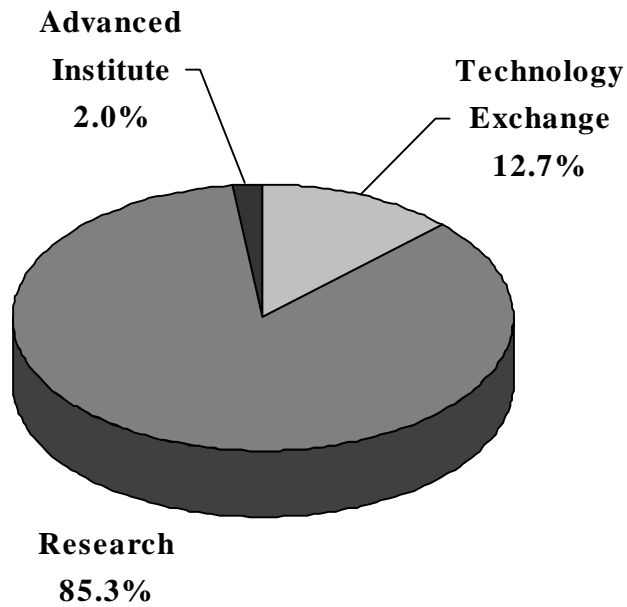
	<b>TECHNOLOGY EXCHANGE</b>	<b>RESEARCH</b>	<b>ADVANCED INSTITUTE</b>	<b>TOTAL PROGRAM</b>
<b><i>SALARIES</i></b>				
Administrative/Professional	\$144,738	\$1,260,954	\$0	\$1,405,692
Faculty	4,541	261,240	9,066	274,847
Support Staff	46,217	577,026	0	623,243
Students/Stipends	6,950	327,375	73,500	407,825
Fringe Benefits	37,463	0 <sup>2</sup>	1,737	39,200
<b>TOTAL SALARIES</b>	<b>\$239,909</b>	<b>\$2,426,595</b>	<b>\$84,303</b>	<b>\$2,750,807</b>
<b><i>EXPENSES</i></b>				
Workshop Fees/Speakers	169,263	0	985	170,248
Sub-contracts/Consulting	15,689	454,934	0	470,623
Operation Costs	180,465	276,996	649	458,110
Signs for Locals	0	16,481	0	16,481
Travel	\$22,929	\$140,742	\$9,016	\$172,687
<b>TOTAL EXPENSES</b>	<b>\$388,346</b>	<b>\$889,153</b>	<b>\$10,650</b>	<b>\$1,288,149</b>
<b><i>CAPITAL EQUIPMENT</i></b>				
Computer Equipment	\$4,145	\$95,860	\$0	\$100,005
Lab Equipment	0	51,243	0	51,243
AV/Furn/Other	0	29,574	0	29,574
<b>TOTAL EQUIPMENT</b>	<b>\$4,145</b>	<b>\$176,677<sup>3</sup></b>	<b>\$0</b>	<b>\$180,822</b>
<b>TOTAL DIRECT COSTS</b>	<b>\$632,400</b>	<b>\$3,492,425</b>	<b>\$94,953</b>	<b>\$4,219,778</b>
<b>INDIRECT COSTS</b>	<b>\$0<sup>1</sup></b>	<b>\$752,848</b>	<b>\$3,280</b>	<b>\$756,128</b>
<b>TOTAL PROGRAM EXPENDITURES</b>	<b>\$632,400</b>	<b>\$4,245,273</b>	<b>\$98,233</b>	<b>\$4,975,906</b>

<sup>1</sup>Technology Exchange does not reflect overhead costs to the program. These costs are contributed by the University and represent approximately 30 percent.

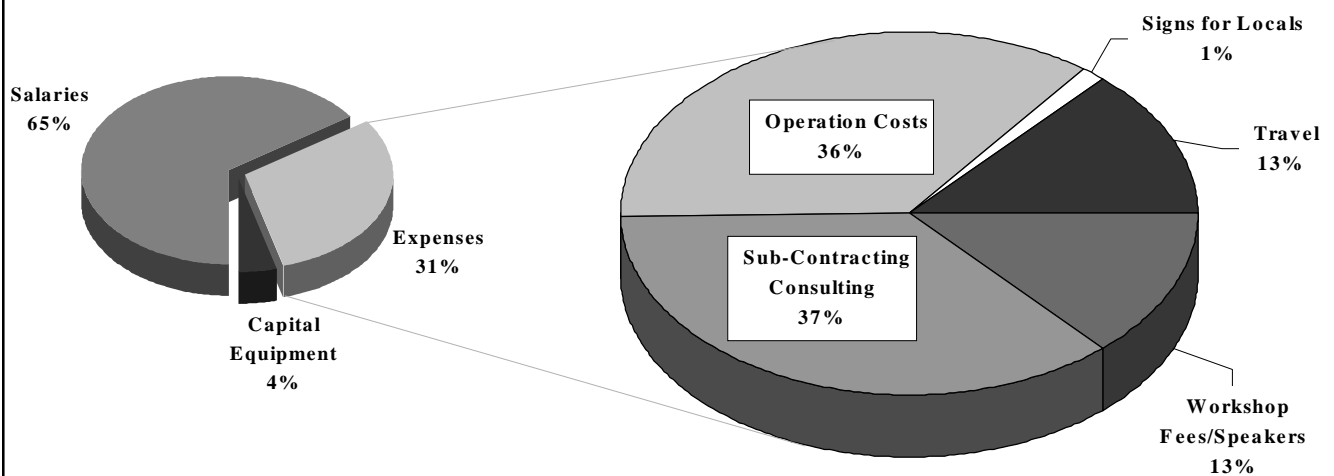
<sup>2</sup>The Research Program implemented a cost-recovery system effective July 1, 1991; therefore, research salaries include fringes and some general operating costs.

<sup>3</sup>\$58,016 (33%) for research equipment was from Kentucky Transportation Cabinet equipment and maintenance funds.

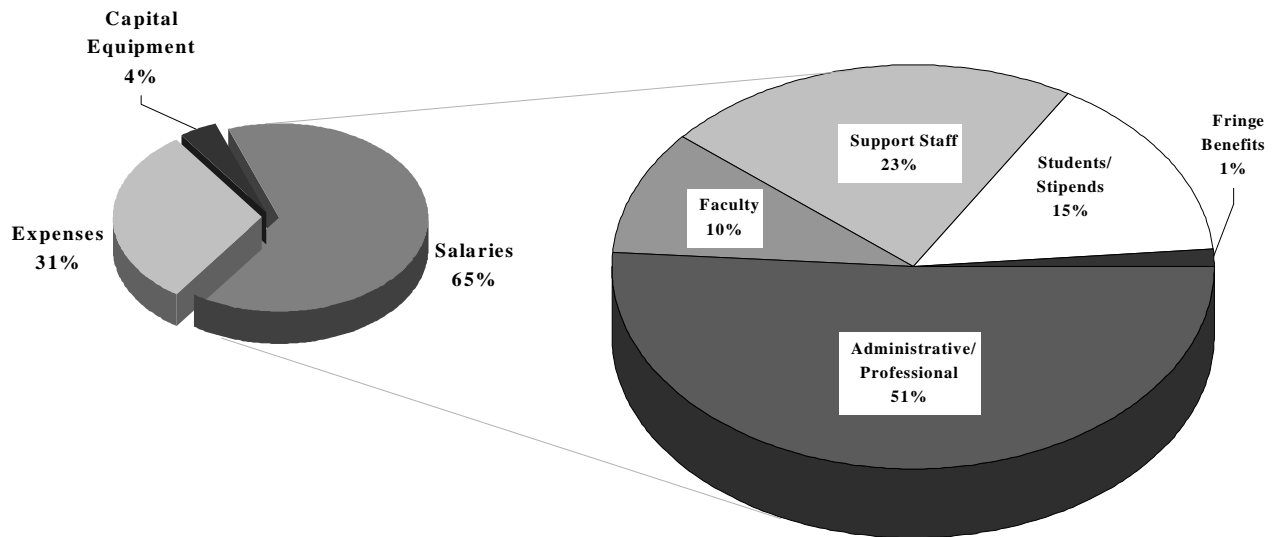
### ***FY 96-97 Expenditures***



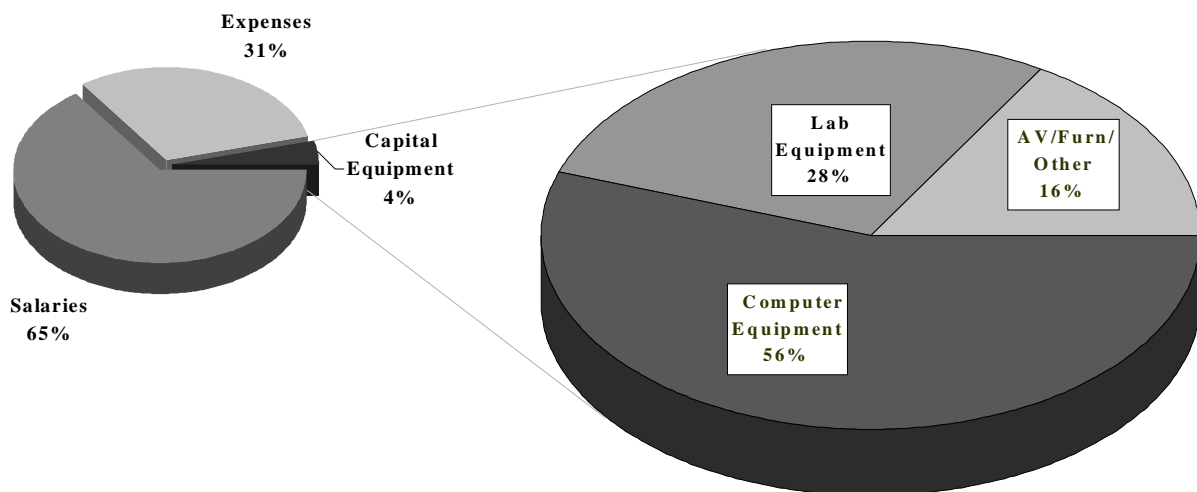
### ***FY 96-97 Expenses***



## ***FY 96-97 Salaries***

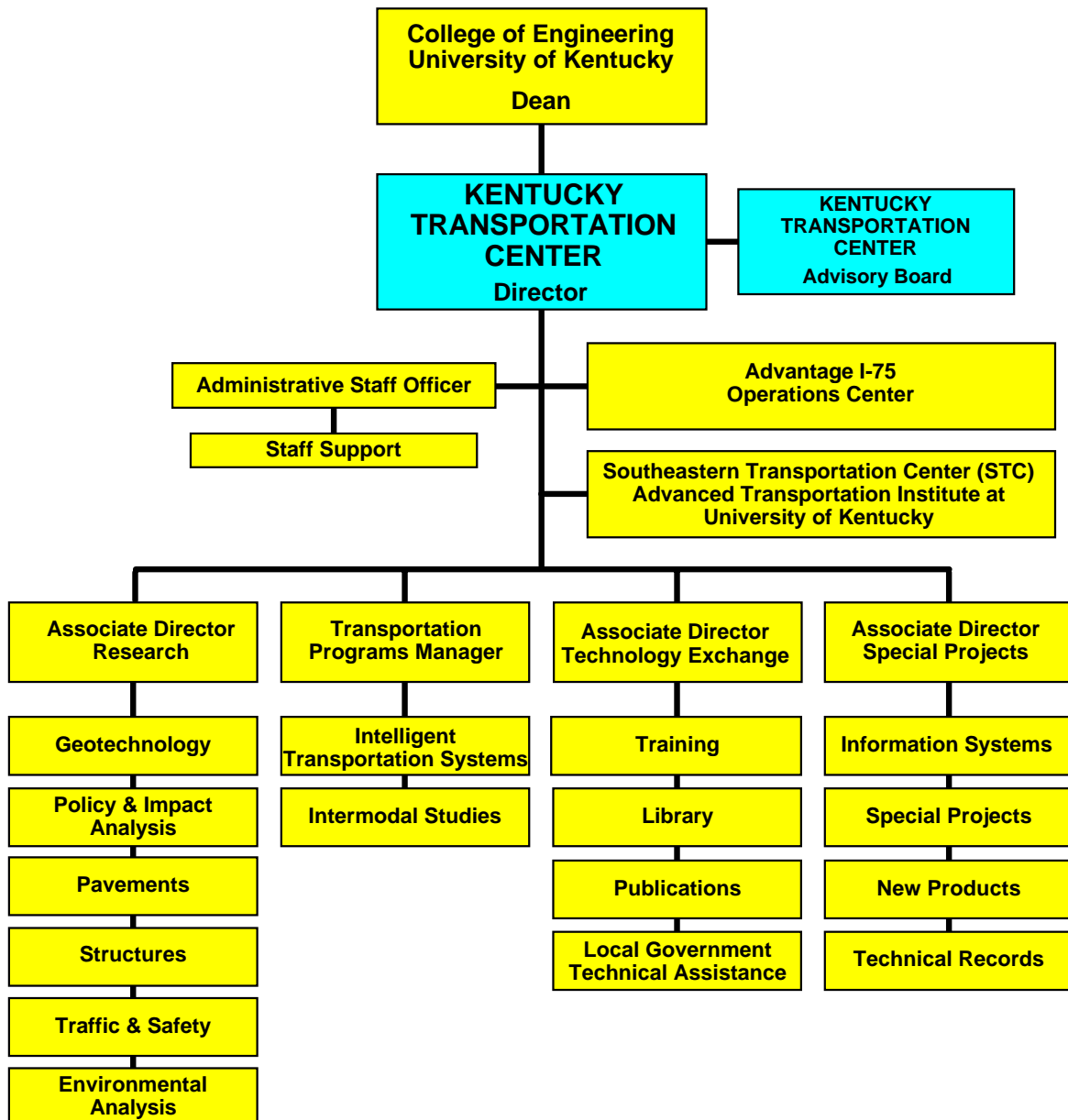


## ***FY 96-97 Capital Equipment***





# Organizational Chart



# *Advisory Board*

*1996-97*

In 1984, the Kentucky General Assembly created the Center's Advisory Board of nine members to assist in policy formation and direction. The Board has the responsibility of reviewing the Center's activities, reporting to the Governor annually, and advising the General Assembly biennially.

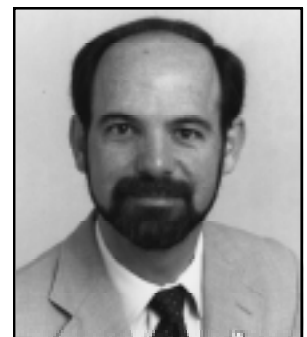
Both direction and accountability are meant to be ensured by the Board, whose members include Kentucky's Transportation Secretary, the State Highway Engineer, representatives of local government, and representatives of the private sector.



*James C. Codell III  
Transportation Secretary*



*J. M. (Mac) Yowell  
State Highway Engineer*



*Thomas W. Lester, Dean  
UK College of Engineering*



*Patricia V. Durbin  
Mayor of Elizabethtown*



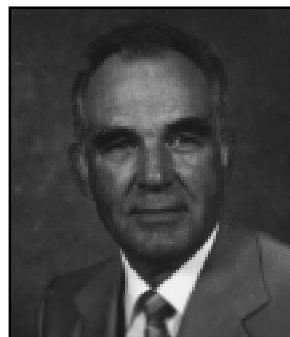
*June D. Lyne  
Olmstead, Kentucky*



*Sherman Neace, Perry  
County Judge-Executive*



*Ralph Palmer  
Palmer Engineering*



*Buddy Smith  
Paducah, Kentucky*



*Sandy Lee Watkins, Hender-  
son Co. Judge-Executive*

# Current Staff

**MAIN NUMBER: 606-257-4513**

## **ADMINISTRATION**

## **EXTENSION**

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Schweitzer, Kathy .....	Receptionist and Staff Assistant .....	221 .....	kschw01@engr.uky.edu

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